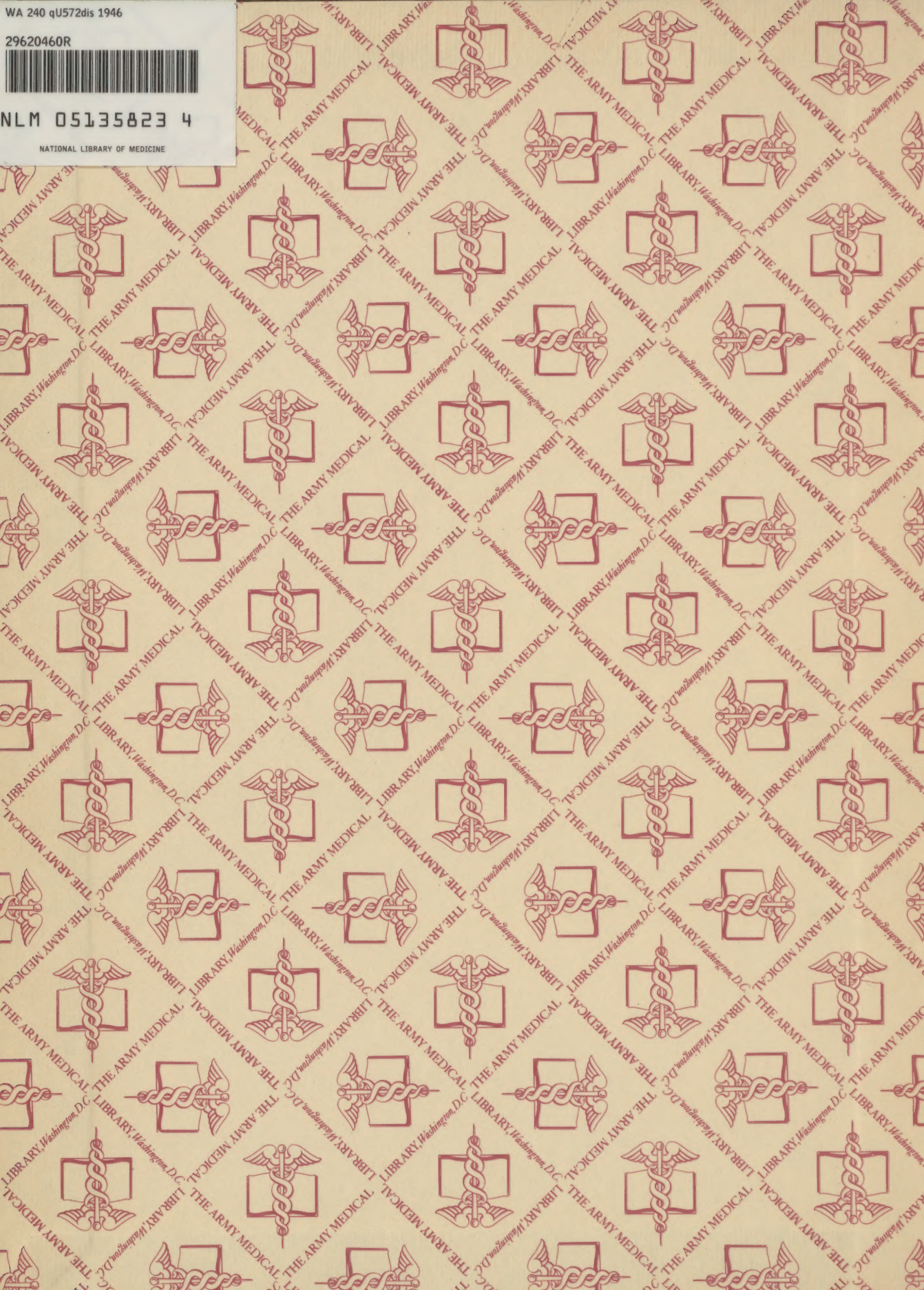

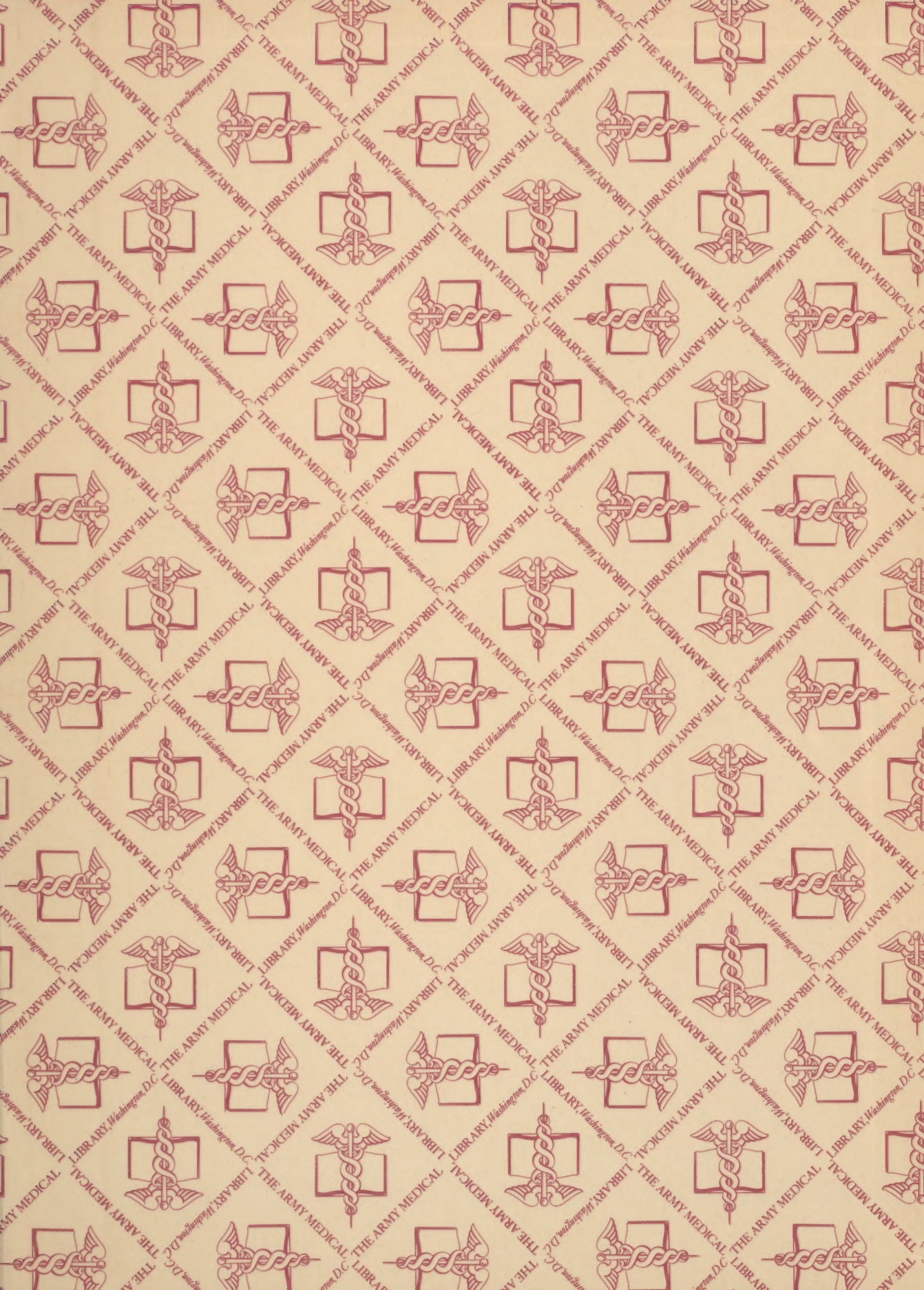
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REPORT
OF
THE AIR PROVING GROUND COMMAND
EGLIN FIELD, FLORIDA

TEST CONDUCTED BY
ORLANDO, FLORIDA

U.S. Army Air Forces Board

SUBJECT

TITLE DISINSECTIZATION OF AIRCRAFT, USING DDT

PROJECT NO.
4671B725

DATE
18 March 1946

COPY NO. 203

NO. OF PAGES
182

HEADQUARTERS, ARMY AIR FORCES

WASHINGTON

.Y REFER TO:

SUBJECT: Proving Ground Project No. 4671, Disinsectization of Aircraft Using DDT.

TO: Commanding General,
Air Proving Ground Command,
Eglin Field, Florida.

15 NOV 1946

1. Air Proving Ground Project No. 4671, Disinsectization of Aircraft Using DDT, is approved with the following exceptions:

a. The recommended revision of AAF Regulation 61-3 does not meet the present situation. At the time this recommendation was made it would have been valid; but events of the past six months have disclosed the serious threats of agricultural insects that may be transported by aircraft and more stringent regulation is necessary. This Headquarters will follow the general recommendation made and will revise this to meet the standards required by the Department of Agriculture.

2. An educational program covering the technique and the importance of aircraft disinsectization is being prepared by this Headquarters.

3. It is desired that the following be added to the distribution list:

The Surgeon General, U. S. Army	12 copies
Chairman, Army Committee for Insect and Rodent Control, Room 2E 289, The Pentagon	25 copies
The Surgeon General, U. S. P. H. S.	12 copies
U. S. Department of Agriculture	12 copies
Chief of Engineers	2 copies
Quartermaster General	2 copies

4. The report of Project No. 4671, Disinsectization of Aircraft Using DDT, will be distributed without incorporating any changes.

BY COMMAND OF GENERAL SPAATZ:

for Leslie O. Peterson, Col. A.C.
ALFRED R. MAXWELL
Brigadier General, U.S.A.
[illegible], Requirements Division
Office Asst. Chief of Air Staff - 3

5325

THE ARMY AIR FORCES BOARD
ARMY AIR FORCES PROVING GROUND COMMAND
Orlando, Florida

16 May 1946

ARMY AIR FORCES BOARD PROJECT NO. 4671B725

TITLE DISINSECTIZATION OF AIRCRAFT, USING DDT

1. Inclosed herewith is copy of final report of AAF Proving Ground Command, Orlando, Florida, dated 18 March 1946, subject as above.

2. This project was initiated at the request of Headquarters, AAF, 19 May 1945.

3. The AAF Board concurs in the conclusions and recommendations of the inclosed report:

a. It is further concluded that:

(1) Disinsection of aircraft can be accomplished by the use of DDT.

(2) Disinsection of aircraft can be accomplished by the combined use of properly applied DDT-pyrethum aerosols and DDT residual treatments, but not by either of these methods alone.

(3) The proper use of DuPont "Deenol 50-F", a dispersible DDT formulation, produces no detrimental effects on personnel, instruments, or parts of the aircraft.

(4) The proper use of DDT-pyrethum aerosol has no deleterious effect on the materials of aircraft construction.

(5) The use of DDT-pyrethum aerosol should be confined to ports of departure since its use at ports of entry would introduce the risk of forcing insects from the aircraft.

(6) The "Lofstand Sprayer" (Corps of Engineers, Stock No. 41-7839.400.030), with the addition of a short, angled spray tube as described in inclosed report, is suitable for depositing aqueous suspension DDT residues in most parts of aircraft.

(7) Widespread, general insect control on and around airports, and proper landscaping and control of vegetation on airports, are important means of preventing introduction of foreign insects, since they decrease both insect entries into aircraft and the chances of insect survival and reproduction on escaping from aircraft.

b. It is further recommended that:

(1) The proposed revision of AAF Regulation 61-3, "Flying, Outside the United States", be published in the form suggested in Inclosure 26 of inclosed report.

(2) An AAF educational program be instituted immediately to acquaint all AAF personnel with the reasons for aircraft disinsection.

4. Inclosures:

a. Incl. 1 - Directive letter from Hq AAF, dated 19 May 1945.

b. Incl. 2 - AFPGC final report.

FOR THE ARMY AIR FORCES BOARD:

E. L. EUBANK
Brigadier General, U. S. Army
President

OFFICIAL:

B. V. PEPITONE
Major, Air Corps
Recorder

HEADQUARTERS, ARMY AIR FORCES
Washington

AFTAS 19 May 1945

SUBJECT: Supplemental Tests to be Conducted under Project No. 4095BG725

TO: President, AAF Board, Orlando, Florida

1. Authority is granted to conduct supplementary tests under Project No. 4095BG725, "Test to Determine Suitability of Specially Designed Spray Equipment for Dissemination of DDT from B-25 and C-47 Aircraft," as follows:

a. To determine the effectiveness of exhaust generated DDT sprays from aircraft.

b. To determine the most practical means of disinsectization of aircraft with DDT, or other insecticides.

2. In regard to the tests referred to in paragraph 1a, preliminary tests by the National Defense Research Committee and the United States Navy have shown promise of producing through the use of exhaust generated sprays results comparable to those obtained with the use of direct sprays through specially designed dispensers, the value of which has been determined in previous tests under this project. The proposed method produces spray particles of smaller diameter and permits the coverage of greater areas, through the use of special equipment and concentrated spray solutions. Controversial points such as the relative merits of various particle sizes, the use of bi-motored planes, and the effects of convection currents at various times of day remain to be answered. Equipment for the dispensing of exhaust generated sprays has been developed by the National Defense Research Committee and the Air Technical Service Command. It shall be the purpose of these tests to determine the efficiency of exhaust generated sprays from aircraft, and further to conduct such comparative studies as will indicate the relative efficiency of the exhaust generated spray equipment and the equipment employed in previous tests under this project. The tests should be initiated immediately to take full advantage of mosquito populations in areas adjacent to Orlando, Florida. The following factors should be taken into consideration:

a. This Headquarters has contacted the Equipment Laboratory, Engineering Division, Air Technical Service Command and has been informed that a C-47 type aircraft has been equipped with the necessary apparatus and is available for the conduct of these tests.

b. It is essential that contact be maintained with the Air Technical Service Command relative to this project, and it is further desirable that contact be made with the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, the National Defense Research Committee, and other interested agencies.

c. Necessary coordination will be effected locally for the selection of suitable test sites, on the basis of mosquito population, foliage cover, accessibility, and general availability.

3. The tests authorized in paragraph 1b are necessitated by the probability of transportation of infected insects or potential disease vectors from infected to non-infected areas, and the resultant danger of epidemics of such diseases as dengue fever, yellow fever, or malaria. The following factors should be taken into consideration:

a. Development and testing of methods of obtaining a satisfactory residual deposit of DDT on all aircraft surfaces where insects may be carried.

b. Determination of the over-all efficiency of this residual deposit combined with aerosol treatment for complete disinsectization.

c. Prevention of any detrimental effect of insecticides, solvents, or methods of application on personnel, instruments, or parts of aircraft.

d. Determination of the most desirable equipment for application of the insecticide. Such equipment must be readily available or easily improvised in all theaters.

e. Studies will be carried out in a number of the types of aircraft most used for inter-continental transportation of personnel and cargo.

f. An officer qualified by training and experience should be assigned to conduct these tests.

g. When necessary for the successful completion of the tests, communication is authorized with The Surgeon General, United States Army; the Inter-departmental Quarantine Commission; the Orlando Laboratory, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture; and other interested agencies.

4. It is suggested that these tests be accomplished on first priority.

BY COMMAND OF GENERAL ARNOLD:

/s/ H. S. Ecklund, Col. AC
for DONALD WILSON,
Major General, U. S. Army,
Asst. Chief of Air Staff,
Operations, Commitments &
Requirements

HEADQUARTERS
AAF PROVING GROUND COMMAND
ORLANDO, FLORIDA

18 March 1946

ARMY AIR FORCES BOARD PROJECT NO. J-4671

Disinsectization of Aircraft, Using DDT

I. OBJECT:

The object of this project is to determine the most suitable methods of disinsectization, by DDT and other means, of aircraft departing from areas infested with pest and disease-bearing insects. To accomplish this, methods of treating aircraft with both DDT-pyrethrum aerosol spray and DDT residue applications have been thoroughly investigated, not only for insecticidal efficiency, but also for practicability. Aircraft operational conditions bearing on the uses of these methods of disinsectization have been studied. Finally, conditions at tropical airports have been observed so as to enable the formulation of recommendations regarding airport insect control. All of these are basic factors in the fundamental purpose of the work--the prevention of the airborne introduction from one region into another of insect disease vectors or economic pests.

II. FACTUAL DATA:

a. Existing Regulations. Disinsectization is required at present under the provisions of AAF Regulation 61-3 (Sec IV and Appendix 1), "Flying, Outside the United States. Quarantine", dated 9 August 1944. In this the use of the pyrethrum aerosol dispenser alone is specified and the methods of its use are described. During the present study the provisions of this regulation and the worth of the DDT-pyrethrum aerosol treatment were evaluated.

b. Preliminary Aerosol Work and Report.

(1) The majority of the work on evaluation of the DDT-pyrethrum aerosol treatment was covered in: Report of the Army Air Forces Center, Orlando, Florida, subject: "Preliminary Report on Disinsectization of Aircraft, Using DDT." AAF Board Project No. 4671B725, dated 22 August 1945.

(2) In this report it was shown that, although houseflies and Anopheles mosquitoes in aircraft can be killed by DDT aerosol treatment alone, dosages considerably greater than those specified in AAF Regulation 61-3, as well as extremely careful techniques in disinsectization, are necessary for security. The dosages needed are so heavy, in fact, that it is not believed they are practical for use in aircraft because of discomfort to personnel. When control of certain agricultural pest insects was attempted with the DDT aerosol treatment alone, it was found that enormously increased dosages would be necessary, dosages so great that their routine use is obviously impractical.

c. Concluding Aerosol Work. A few additional tests of aerosol disinsectization were made after the preparation of the Preliminary Report. Pressure of time prevented longer continuation of this work; but it is believed that the additional tests justified in every way the basic conclusions reached in the preliminary work.

(1) Evaluation of Cage Tests. Since it was felt that the use of wire screen aerosol test cages tended to shield the test insects to some degree from the aerosol spray, and thus to cause lower kill rates among them, three series of tests were made to measure the ratio of the amount of aerosol spray penetrating the cages and depositing on a given area, to the amount depositing on the same area unshielded by wire screening. This was done by placing clean microscope slides in horizontal positions inside aerosol test cages in various locations in a closed chamber. Other slides in corresponding positions were then placed outside of and close to the cages, and a dose of aerosol spray released. The number and diameters in micra of the droplets on identical areas of both caged and openly exposed slides were then counted. The radii were cubed, giving a figure termed the "Droplet Mass Index" (DMI), and the results consolidated. It was not considered necessary to multiply these figures by pi and thus to find the actual volumes of the droplets, since this would not have altered the ratios between the figures for caged and openly exposed slides. A summary of these tests is given in Inclosure 2, and their significance discussed in Sec IV, par a (1) (a) below.

(2) Comparison of Cage and Free-Flight Tests. A number of "free-flight" tests were made in which test insects were released in closed aircraft and subjected to aerosol treatment. These are summarized in Inclosure 3. Results of these tests varied considerably, and unfortunately, since time did not permit the making of enough tests to obtain conclusions that would be statistically significant and comparable. Those made tended, however, to corroborate strongly the results of the cage tests described above in showing that only

about one-half to one-third as much kill was obtained with caged insects as with free ones. This figure is, however, an approximation. The matter is discussed in Sec IV, par a (1) (b) below.

(3) Tests for Value of Aerosol Residue Deposition. A series of tests was made in four C-47 aircraft to determine what value, if any, DDT aerosol treatments might have in building up a worthwhile DDT residue in aircraft. The aircraft were sprayed for 60 seconds each time with a Westinghouse aerosol dispenser, DDT Lot No. 2. A settling time, usually of 6 minutes but in some cases of 30 minutes, allowed the spray to settle and deposit.

Standard residual test cages were used. Houseflies were used as test insects. Two tests were usually run daily, one just before the spraying to evaluate the residue remaining from previous treatments, the other immediately after the end of the settling time to evaluate the toxicity of any freshly deposited residues.

Test cages were placed in the following locations:

Quilted fabric lining, baggage compartment (V)
Matting on floor, navigator's compartment (H)
Top, navigator's table (H)
Drop leaf, navigator's table (V)
Side wall above window, cargo compartment (V)
Top, duralumin bucket seat (H)
Back brace, bucket seat (H)

(H) = horizontal surface

(V) = vertical surface

These locations insured tests on horizontal and vertical surfaces of matting, cloth, wood, painted duralumin and unpainted duralumin.

All aircraft were in normal operational use during tests, flying about two days out of three and averaging about 6 hours flying per day. This use of operational aircraft was, of course, highly desirable in order to give a true picture in the tests; but it caused some difficulty due to the occasional unavailability of aircraft for testing when needed. As a result, the tests were not run as consistently as might have been desired.

Results of these tests are shown in Inclosure 4 and discussed in Sec IV, par a (4).

(4) Automatic Aerosol Disinsectization. There has recently been published a description of what appears to be a highly efficient apparatus for "automatic disinsectization" in aircraft. This is "A Preliminary Report of the Development of Equipment for the Automatic Disinsectization of Airplanes" by Donald L. Snow, Pan American Sanitary Bureau, S. A. Sanitary Engineer, United States Public Health Service (Washington, D. C.) August 15, 1945.

The apparatus appears efficient, and is surprisingly light, weighing only approximately 17.55 pounds. It releases the aerosol spray from a number of points, which can be located so as to insure proper distribution of the spray. It also sprays a predetermined, accurate dosage. In both these respects it does much to eliminate human error and fallibility, intentional or otherwise.

The further development of this apparatus should be followed closely with the purpose of considering its ultimate adoption on aircraft engaged in flights where disinsectization is necessary.

(5) Harmful Effects of Aerosols. Tests were conducted by the Air Technical Service Command to check on the safety to materials of aircraft and instrument construction with which the standard DDT-pyrethrum-freon aerosol could be used in aircraft. Results of these tests, which cleared this for aerosol but not for heavy residual use, are contained in par 10, 14, and 15 c of Inclosure 5.

d. Tests of Residual Treatment Materials. A series of tests of various methods of applying a DDT residue was made by the Air Technical Service Command. These were to determine what solvents or other vehicles for DDT might be used inside aircraft without causing damage to any of the parts of the aircraft, to instruments, or to apparatus. The results of these tests are shown in Inclosures 5-8.

(1) Tests were made of the chief solvents used for DDT.

(2) Tests were made of the CWS DDT E-22 Smoke Candle.

(3) Tests were made of a considerable number of formulations of "dispersible DDT". These are mixtures of DDT with various other substances which serve as wetting, suspension-stabilizing, and sticking agents.

(4) A number of trials of DDT dusts were made at Orlando to test the practicability of this method of applying a DDT residue in aircraft. Three types of dust were used; these were:

4.75% DDT in grey Antico (micronized slate).
9.0% DDT in grey Antico (micronized slate).
10.0% DDT in pyrophyllite (QM Stock No. 51-I-180).

The observations made during these trials are summarized and discussed in Sec IV, par b (4) below.

(5) A series of tests was made at Orlando for the purpose of determining the residual toxicity shown by formulation DuPont 6327-33B. This formulation was favored by the Air Technical Service Command in their report (Inclosure 5, pars 4 and 15) because of the belief that the addition of large amounts of polyvinyl alcohol (RH 403) would cause a greatly increased durability of the residue. The tests compared deposits of 5, 10, 50 and 100 mg of DDT per square foot of this formulation and 6002-62, a standard 90% formulation. Twenty comparative tests were made at concentrations of 5mg and 10 mg DDT per square foot, and 41 tests were made at concentrations of 50 mg and 100 mg DDT per square foot. Since the test flies cause very heavy wear in the small spaces under the test cages, these gave a very good index of the comparative durability of the residues. The data on these tests are shown in Inclosure 15 and discussed in Sec IV, par e (3) below.

e. Tests of Spraying and Treating Equipment. A number of methods of applying residues with DDT aqueous suspensions were used and tested during the work, as listed below.

(1) Lofstrand Model NER 106 Knapsack Sprayer. This sprayer, a recently developed item of official issue (Corps of Engineers item, Stock No. 41-7839.400.030, Sprayer, insect, knapsack-type, plunger-type, cylindrical shape, 3-gallon capacity), was used in a considerable number of laboratory tests, as well as in most of the actual spraying in the aircraft. It comes equipped with four nozzles, as follows:

No. 1 - Solid stream
No. 2 - Flat spray
No. 3 - Cone spray
No. 4 - Mist spray

These nozzles were tested for suitability as to volume of output, evenness of coverage, size of droplets and liability to clogging. Results of these tests are discussed in Sec IV, par c (1). Use of the sprayer is illustrated in Inclosure 10.

(2) Sprayer, liquid, insecticide, continuous spray, 2-quart or 3-quart. This sprayer (QM Stock No. 41-S-4105) was tested for use in aircraft as a substitute for the Lofstrand sprayer. Results are discussed in Sec IV, par c (2) below.

(3) "Sure-Shot Sprayer". This item, which has been widely used as a sprayer for pyrethrum insecticides by such organizations as the U.S. Public Health Service, was tested for suitability for DDT aqueous suspension spraying in aircraft. Results are discussed in Sec IV, par c (3) below.

(4) Painting. It was demonstrated that, lacking spray equipment, DDT aqueous suspensions can be applied in aircraft by simply using paintbrushes. Details are discussed in Sec IV, par c (4) below.

f. Spraying and Treating Techniques. Apart from the testing of the various sprayers listed above, it was considered advantageous to make notes on special techniques for treatment of aircraft. These are discussed in detail in Sec IV, par d below.

g. Test Insects. As nearly as possible, standardized test insects were used. The houseflies and mosquitoes were obtained from the cultures of the Orlando Laboratory, United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Division of Insects Affecting Man and Animals. The agricultural pests used in the aerosol tests were captured locally by the representatives of the Division of Foreign Plant Quarantine of the Bureau of Entomology and Plant Quarantine.

Personnel from this Division who were temporarily stationed at Orlando, furnished invaluable assistance. It is extremely unfortunate that they were unable to remain for the residue testing. Because of this, and also owing to seasonal changes, agricultural pests were not available in sufficient quantities for the residual tests. The published literature of economic entomology is, however, fast filling up with references to the effect of residual DDT on pest insects.

h. Laboratory Residual Toxicity Tests. A series of tests was made with four formulations of "dispersible DDT" in aqueous suspensions, on samples of various materials from the interior of aircraft. These were to determine the residual toxicity of the various formulations; the effects, if any, of the various aircraft materials on the durability of this toxicity; the effects of wiping the treated surfaces on the durability of the toxicity; and finally, the general practicability of using these formulations for residual control of insects in the interior of aircraft.

(1) Test Methods and Procedures. The tests were prepared and run as follows:

(a) Formulations: The formulations used were Code Nos. 6002-20, 6002-62, 6002-64 and DuPont Deenol 50-F. These contain 91%, 90%, 94% and 50% DDT respectively, with varying amounts of wetting, sticking and suspension stabilizing agents. (See Inclosure 12).

Suspensions of the various formulations were prepared containing 5% DDT (weight-volume). Each formulation was then applied to two samples of each material so as to deposit DDT residues of 200 mg per square foot (1 cc of suspension per six-inch square sample).

(b) Aircraft Materials.

The following aircraft materials were tested:

Duralumin, painted
Duralumin, unpainted
Plexiglas
Wing Fabric, aluminum-painted
B-29 Fabric Insulation Lining
B-32 Fabric Insulation Lining

(2) Preparation and Testing of Samples.

(a) Four sets of six-inch square samples were prepared, one set for each of the formulations tested. A set consisted of two samples of each of the materials, except that shortage of material necessitated using only one sample of B-29 lining and one sample of B-32 lining per set.

One sample of each pair, for each formulation, of the unpainted Duralumin, painted Duralumin, Plexiglas and Wing Fabric was then wiped thoroughly with a dry cloth.

One sample of each of the unpainted Duralumin, painted Duralumin, Plexiglas, Wing Fabric, B-29 Lining and B-32 Lining were not wiped, the residue being left undisturbed.

A set of seven toxicity tests was then run on each of the samples, both wiped and unwiped, the intervals between tests averaging two days. (See Inclosures 13 and 14, Series A and C and Inclosure 11).

(b) After these tests all samples were wiped. This meant that those samples previously unwiped received their first wiping, while those which had been wiped before received a second wiping.

Another series of seven toxicity tests, with two-day intervals between tests, was then run on all samples. (See Inclosures 13 and 14, Series B and D).

Wiping the samples had a two-fold purpose. Firstly, it duplicated to some extent the normal wear which a treated surface in the interior of an airplane will receive.

Secondly, it duplicated the wiping which many residual-sprayed surfaces in an airplane will receive in addition to normal wear. The residue from aqueous suspensions is very prominent, and will be objected to; it undoubtedly will have to be wiped off of seats, windows, etc. The tests therefore were intended to establish the worth of what residual toxicity remains in spite of wiping, in addition to normal wear.

(c) Other Test Data. The samples were treated with DDT on 30 August. The last test (of Series C and D) was made on 27 September. The tests therefore demonstrate the durability of the residue over a period of 28 days.

Temperature records were taken during all tests. Temperatures ranged from 79°F. to 93° F.; but study of the records shows no discernible effect of these variations. Standard, laboratory-reared, 4-5 day old houseflies were used in all tests. Standard residual "petri dish" test cages were used (See Inclosure 11).

Three control cages were used for each ten test cages as a check against contamination of cages, abnormal lots of flies, etc. No cases of abnormal mortality were noted, the control mortality after holding for 24 hours averaging less than 0.09%. Time of continuous exposure to the treated surface, until 100% knockdown occurred, was recorded in all tests as the criterion of the toxicity on the surface.

(3) Special Tests, Formulations 6002-62 and 6327-33B (ATSC Type M). A dispersible DDT formulation, 6327-33B, was devised to test the efficacy of adding large amounts of polyvinyl alcohol. (Inclosure 12). Since this substance acts as a binder it was believed that it might prevent excessive wearing away of the residue and thus give a more durable residual toxicity. Accordingly two series of tests were made, in which carefully measured amounts of this formulation and of 6002-62 for comparison were applied to six-inch square test plots of painted duralumin. A pair of plates were prepared with each formulation at concentrations of 5 mg, 10 mg, 50 mg and 100 mg of DDT per square foot.

Tests were then run simultaneously on the paired plates, using approximately equal numbers of houseflies in standard residual test cages (Inclosure 11). The test flies, buzzing and running around caused a very definite wear on the treated surfaces; after a few tests the circular areas could be seen plainly from which they had worn off the residues. Series of 20 paired tests were run with each formulation at residue concentrations of 5 mg DDT per square foot and 10 mg DDT per square foot. Other series were run similarly consisting of 41 paired tests of each formulation at concentrations of 50 mg and 100 mg DDT per square foot. Time in minutes to 100% knockdown of all flies was recorded as the basis for comparison.

The results of these tests are shown in Inclosure 12 and discussed in Sec IV, par e (3) below.

i. Tests of Residual Toxicity in Aircraft. As authorizations, on the grounds of safety to materials of aircraft construction, were received from the Air Technical Service Command, test aircraft were treated with dispersible DDT aqueous suspension residues, and tests run in them.

(1) Not as many aircraft were available as was wished, nor as many types. However, two C-47's, two B-25's and three B-17's were completely treated and used for the tests. Differences between the types used were not of as great importance in this residual work as in aerosol testing. Of primary importance is the fact that the aircraft were in operational use, although not as constantly as might have been desired, so that the work represents a valid field test of the durability of the residues. The list of aircraft used and the dates of the various residual tests made in them are given in Inclosure 21 and the flight logs of the aircraft, showing the amount of operational use they received during the tests are given in Inclosure 20.

(2) Formulations and Concentrations. Inasmuch as the laboratory tests on aircraft materials had shown little, if any, significant difference between the various formulations of dispersible DDT, it was decided to use only two of these in the aircraft tests. DuPont Deenol 50-F, containing only 50% DDT (See Inclosure 12), was chosen because of its commercial availability. The OSRD formulation 6002-160, containing 90% DDT, was chosen as the other because a number of tests of settling rate of its suspensions appeared to show slightly superior qualities in this respect. Unfortunately none of the OSRD formulations already used in the laboratory tests (Sec II, par h) were still available in sufficient quantity to enable their use.

Except in one case, noted below, all formulations were mixed with water to give suspensions containing 5% DDT (weight-volume). These were then applied in the aircraft so as to give approximate DDT residues of 200 mg per square foot. In one aircraft (B-17, No. 042) the suspension was mixed to contain 2-1/2% DDT (weight volume) and this was applied so as to give a residue of approximately 100 mg of DDT per square foot.

In all cases all interior surfaces of the aircraft were treated, care being taken, however, to avoid instruments. This, rather than treatment of only the particular surfaces where test cages might be fastened, was considered advisable since it gave a more accurate picture of conditions in non-experimentally treated aircraft.

(3) In order to test the efficient durability of the residue on surfaces that receive a heavy wear, large areas were wiped with dry cloths after the application had dried on, and tests were run on these as well as on unwiped areas. Both wiped and unwiped areas were, of course, subject to normal wear during the period of the tests. This emphasis on testing deliberately wiped areas was considered highly important because of the inevitability that considerable such wiping will have to be done in any treated aircraft due to objections to the appearance of the residue.

(4) Cage Tests. A large number of cage tests of residual toxicity were made in all the aircraft, as circumstances permitted. In these, the standard residual test cages were used (See Inclosure 11). In order to get a truer picture of the normal wear of the residue, unaffected by the wear due to previous tests, the cages were never placed on the same spot twice. In each test two cages were placed on cloth fabric, wood, plexiglas, painted duralumin and unpainted duralumin surfaces, one cage being on a wiped surface and the other on an unwiped one. Occasionally there was some variation from this basic plan, due to unavailability of unwiped, previously untested areas. It is believed

that this system probably resulted in obtaining a fair picture, by means of the cage tests, of actual conditions.

At least three additional cages were used as controls in each test, being treated the same as the test cages except for actual exposure to the treated surfaces. In a few cases mortality appeared among these controls. In these cases the whole test was discounted, as having been somehow subjected to accidental contamination.

Test insects were exposed for a contact period of two hours. During this time a close watch was maintained on the cages, and if complete knockdown (KD) occurred before the end of the contact period, as usually happened, the time was noted. At the close of the contact period all test insects were transferred to clean, standard holding cages, fed and watered, and held for 24 hours in the Orlando Laboratory. At the end of 24 hours the net mortality was recorded. In no case, incidentally, when complete knockdown was recorded, was there recovery of any of the test insects.

The results of these tests are shown in Inclosures 16 and discussed in Sec IV, par f below.

(5) Free-Flight Tests. A considerable number of "free-flight" tests were made in the treated aircraft toward the end of the testing period. At this time Anopheles were no longer available in quantity, so that only houseflies were used. In all tests the insects were liberated throughout the aircraft and their reactions closely observed during the test. A two-hour contact period was used, as in the cage tests, but in only one test did flies remain active this long. At the end of each test as many as possible of the knocked-down flies were swept up, and held for 24 hours; but in no case was there recovery of any of these.

(a) Tests in Aircraft on the Ground. A majority of the tests were made in aircraft on the ground. The results of these are shown in Inclosure 22 and discussed in Sec IV par g (1) below.

(b) Tests in Aircraft in Flight. A number of the tests were made in flying aircraft. In these the flies were liberated immediately after take-off. The aircraft then remained in the air until the end of the contact period. The results of these are shown in Inclosure 23 and discussed in Sec IV, par g (2) below.

j. Observations on Aircraft. During the course of the work a considerable number of miscellaneous observations were made which, although they do not directly concern the actual tests, have an important bearing on the whole subject of the advisability and suitability of aircraft disinsectization. They include such matters as the tendency of

insects to enter aircraft, the activities of insects in aircraft, the attitude and reactions of personnel to disinsectization regulations and procedures, and similar pertinent subjects. These observations are presented in part in Inclosure 24, and discussed under Sec IV, pars i and k below.

k. Observation at Airports. Killing insect stowaways by disinsectization of aircraft is an extremely important method of preventing introduction of insects from one region to another. However, anything that can be done to prevent the entrance of insects into aircraft is really the "first echelon of defense" against such introductions. It cannot be hoped that such preventive measures will ever become efficient enough to do away with the need for disinsectization. But it cannot be denied that any failure to recognize the potentialities of such preventive measures would be culpable. In this connection a considerable number of observations were made during these tests. These are described and their application discussed in Sec IV, par k below.

l. Miscellaneous Disinsectization Data. During the conduct of these tests it became apparent that it was highly advisable to secure acquaintance with the various regulations and laws on the subject of disinsectization and quarantine of aircraft, since this would enable more intelligent recommendations regarding revision of these regulations, if nothing else. Accordingly, information of this nature was secured whenever possible. It is not pretended that anything like the whole literature on the subject was consulted; but it is believed that enough was studied to enable an intelligent appreciation of the field. A selection of various AAF local regulations, as well as some foreign material, are presented in Inclosure 25, merely as indicative of the ways in which disinsectization was handled in various regions. A short, annotated bibliography, admittedly very incomplete, is also given there.

III. CONCLUSIONS:

General

a. Disinsectization of aircraft to prevent introduction of "stowaway" insects from abroad can be accomplished practicably by the use of DDT.

b. Disinsectization of aircraft can be accomplished by the combined use of properly applied DDT-pyrethrum aerosols and DDT residual treatments, but not by either of these methods alone.

Aerosols

c. Reliance upon disinsectization by DDT-pyrethrum aerosol treatments alone is dangerous. This is due in part to the failure of aerosols to kill many insects except when used in extremely heavy dosages. Such dosages are impractical because of their discomfort, and even potential harm, to personnel, and because of the time they take. It is also due in part to the tendency of personnel to skimp, or even omit altogether, aerosol treatments. And it is also due, in part, to the construction of

many aircraft, which contain many regions into which hand-applied aerosol sprays cannot practicably be made to penetrate.

d. In order to be effective, aerosol disinsectization must be performed very carefully and conscientiously.

e. The application of aerosol treatments in aircraft by "automatic" mechanisms, controlled from a single point, is a promising field that merits further investigation.

f. Aerosol disinsectization loses much of its effectiveness when performed during flight.

g. Reliance should be placed only on aerosol disinsectization at ports of departure. A supplementary and additional aerosol treatment may be given at ports of entry also, if desired; but it would be dangerous to permit this supplementary treatment to minimize in any way the primary importance of the treatment at the port of departure.

h. The DDT residue deposited by even impractically heavy, daily, DDT-pyrethrum aerosol treatments of aircraft is evanescent and nearly valueless for disinsectization.

i. Aerosol treatments have important secondary effects in stimulating insects to hyperactivity. This causes them to contact greater doses of insecticides, both airborne and residual. It also tends to drive them to seek escape from the aircraft.

Residues

j. Disinsectization by DDT residual treatment alone is unreliable because of the impossibility of thus controlling insects resting on personnel, baggage and cargo, or on surfaces from which the residue may have been too thoroughly worn away.

k. Aqueous suspensions of "dispersible DDT" are a safe and efficient means of depositing DDT residues in aircraft. These residues will stay highly effective for a month or more in aircraft in operational use, even though many of the surfaces on which they were applied may have been wiped or worn apparently clean.

l. DuPont "Deenol 50-F", a dispersible DDT formulation containing 50% DDT that is at present available commercially, is adequate for use in aircraft residue treatment. It is, however, not as satisfactory as formulations containing approximately 90% DDT. These latter can quickly be made available commercially.

m. No significant differences in toxicity were observed between equal residues of DDT deposited with formulations 6002-20, 6002-62, 6002-64, 6327-33B, 6002-160 and Deenol 50-F.

n. The residues deposited by applications of various dispersible DDT formulations giving equal amounts of DDT per unit of area are visible and objectionable in inverse ratio to the percentages of DDT in the formulations. Formulations containing high percentages of DDT such as 90%, are preferable for this reason.

o. No significant increase of toxicity or of durability of toxicity was observed in tests of DDT residues from formulation 6327-33B containing a large percentage of polyvinyl alcohol.

p. No compounds at present practical for use as solvents of DDT can be used safely in aircraft because of damage to materials of aircraft, instrument and equipment construction such as rubbers. DDT solutions and emulsions are therefore unsatisfactory for use in aircraft.

q. Dusting as a means of depositing a DDT residue in aircraft is inefficient, messy and unsatisfactory.

r. Smoke grenades or candles as a means of depositing a DDT residue in aircraft are inefficient and dangerous.

Spraying Equipment

s. The "Lofstrand Sprayer" (Corps of Engineers Stock No. 41-7839.400.030, Sprayer, insect, knapsack-type, plunger-type, cylindrical-shape, 3-gallon capacity) is suitable for depositing aqueous suspension DDT residues in most parts of aircraft. The ordinary issue general purpose insect sprayer (QM Stock No. 41-S-4105, Sprayer, insecticide, continuous spray, 2-quart or 3-quart) can also be used but is less satisfactory. The "Sure-Shot" Sprayer (Milwaukee Sprayer Mfg., Co., Inc., Milwaukee, Wis.) is also satisfactory for this work, its low output making it most suitable for spraying around instruments and in small areas.

Miscellaneous

t. Anopheles quadrimaculatus proved somewhat more susceptible than houseflies to DDT residues.

u. Widespread, general insect control on and around airports, and proper landscaping and control of vegetation on airports, are important means of preventing introduction of foreign insects, since they decrease both insect entries into aircraft and the chances of insect survival and reproduction on escaping from aircraft.

v. Army personnel in general fail almost completely to realize the importance of aircraft disinsectization.

IV. DISCUSSIONS

a. Aerosol Treatments. The problem of deciding what constitutes

an adequate, yet practical, aerosol treatment is an extremely complex one, affected by many important factors. These are:

(1) Dosages. The "standard dosage", for purposes of discussion here is taken to be the 15 seconds required by AAF Regulation 61-3, 9 August 1944, for a C-47 or other similar sized aircraft, with a holding time of 2 minutes. In the preliminary Aerosol Report (See Sec II, par b above), it was shown by cage tests that this dosage was inadequate and that an increase to a 90 second dosage and a 5 minute holding period would apparently be necessary to insure kill of all mosquitoes; an increase to at least 3 minutes would be necessary to give a reasonable assurance of housefly control of certain agricultural pest insects. On the bases of these tests, lacking full information from screen-cage evaluation tests and free-flight tests, and considering the absolute lack of certainty at that time of any probability of DDT residual control, a greatly increased aerosol dosage was recommended, purely as a temporary measure, for mosquito control only. At the present time, however, the picture has changed. Some figures are now available from both screen-cage and free-flight tests (See Sec II, par c); and it is certain that DDT residual treatments can be applied that will give excellent results. A complete re-evaluation of aerosol dosage is therefore in order, as follows:

(a) Screen-cage Tests. As pointed out in Sec II, par c (1) the evaluation of the tests tabulated in Inclosure 2 show that in static cages only about 1/2.3 as much spray will penetrate to caged insects as to free ones. These figures are not final; but it is believed they do show that a considerable reduction could be made from the 90 seconds that the preliminary report recommended, for mosquitoes, in a C-47 or similar sized aircraft.

(b) Free-flight Tests. The various free-flight tests made with agricultural pests (Inclosure 3) show conclusively the futility of attempting to control such insects with any practicable aerosol treatment alone. They also, when compared with aerosol cage tests on the same insects, show that actually a far greater kill, possibly even five to ten times as great, will be obtained on free insects than on caged ones. The decreased dosage of aerosol spray that penetrates the screen cage is undoubtedly responsible for some of this difference. It is believed that an even more important factor is the tendency of free insects to fly and run, and thus to contact, not only a much greater airborne droplet dosage, but also a greater dosage from droplets that have landed on the floor and formed a genuine, though temporary residue. It is therefore believed that the free-flight tests, like the screen-cage tests, show the propriety of a

considerable reduction from the 90 second dosage that the preliminary report recommended, for mosquitoes, in a C-47 or similar sized aircraft.

(c) Purposes of Aerosol Treatments. It may seem that the purpose of aerosol spraying in aircraft is simple and obvious, i.e., to kill insects directly. Actually this apparently simple matter is really complex, and requires analysis and clarification.

1. Primarily, of course, the aerosol spray is intended to contact, and thereby to kill, insects in the aircraft. However, in the light of the present work a more detailed evaluation is necessary as to what insects the aerosol spray should be expected to kill. It has been shown that mosquitoes can be controlled with dosages that are practicable for use; but that insects with a somewhat higher degree of resistance to DDT and pyrethrum, such as houseflies, will require larger dosages; and that, although doubtless many other insects can be controlled with moderate dosages, no reliance can be placed on practical doses of aerosols for general insect control. It is essential that these limitations of aerosol treatment be clearly understood; otherwise a tendency to expect more of the aerosol spray than can be accomplished practicably with it will cause confusion.

2. Two secondary, or indirect, benefits derived from aerosol treatment have hitherto been ignored. The spray stimulates insects to abnormal activity. One result is that many insects may promptly seek and find exits from the aircraft. (See Tables 1 and 5, Inclosure 3). This is beneficial if it occurs at the port of departure of the aircraft, for there the exit of insects from the plane does no harm; but if it occurs at a port of entry it may be dangerous, forcing insects out of the plane before they can contact a lethal dose of insecticide. A second important result is beneficial; the hyper-stimulated insects tend to contact greater dosages, not only of the aerosol but of any DDT residue in the aircraft. It can thus be seen that the aerosol may indirectly, as well as directly, act as an important auxiliary to a properly applied residual treatment.

(d) Personnel Factors. It would be dangerous to ignore the fact that the personnel in aircraft often object strongly to having to sit in a fog of more or less irritating aerosol spray. However much one may talk about the sanctity of regulations, one fact must be faced: if a very heavy aerosol dosage is ordered there will inevitably be evasions with resultant poor disinsectization. With this in mind it is incumbent that no greater aerosol dosage be required by regulations than is needed; otherwise the regulation will defeat its own purpose.

(e) Summary. Taking the above factors into consideration, it is believed that a basic aerosol dosage of 30 seconds spraying in a C-47 or similar sized aircraft is to be recommended, with proportionate dosages in other sizes of aircraft, when a proper DDT residue is present. By itself this dosage is probably adequate for mosquito control, if properly applied and distributed (See pars a (2) and (3) below). It alone will probably kill a large percentage of the flies in the aircraft. It will definitely not kill more than a very small percentage of many other species of insects, but, as has been seen, no aerosol treatment can be relied upon for miscellaneous insect control anyway. It will be sufficient to stimulate any insect in the aircraft to hyperactivity, and thus to produce the important secondary effects discussed above. And it will not be so heavy as to cause too great resentment on the part of personnel in the aircraft and thereby cause evasions and inadequate treatments.

The above conclusion is admittedly a compromise, but it is believed to be the most practical one that can be reached. However, the factors involved are so incapable of exact formulation that exact evaluation is impossible and individual bias may well play a part in the final making of the decision on dosage.

It must again be stressed that this recommendation for a dosage somewhat lower than that recommended in the preliminary report is conditional upon the presence in the aircraft of an adequate DDT residue.

(2) Time and Place of Treatment. Tests made during the preliminary aerosol work and described in the preliminary report (See Sec II, par b above) showed the necessity of performing aerosol disinsectization only while the aircraft is on the ground, and while the engines are not operating. This makes the period just before the final warm-up of the engines best adapted for this treatment.

As shown in par a (1) (c) above, it is highly important that aerosol disinsectization should not be performed at ports of entry, either before or after landing.

(3) Methods of Application. In the preliminary report it was demonstrated that great care must be exercised to insure a thorough and even distribution of aerosol spray throughout the aircraft. Inter-compartment doors should be kept closed, each compartment being sprayed separately. Trap doors, cabinet and cupboard doors, tops of ammunition and storage boxes, etc., should be opened so that the spray can penetrate into all potential insect hiding places. The spray should be conscientiously directed into semi-enclosed spaces, such as under seats, behind instruments, tanks and apparatus. Spaces behind and between cargo and baggage are especially important, and should have the spray deliberately directed into them.

(4) Value of Aerosol Residue Deposition. The tests described above in Sec II, par c (3) and tabulated in Inclosure 4 do not appear to have demonstrated the deposition of any worthwhile DDT residue. Those made in aircraft Nos. 933, 841 and 688 were too few to give significant results. Owing to the pressure of time and the constant operational use of these aircraft, no more tests could be made in them. They suggest, at times, a possible slight buildup of a residue; but results are erratic. It is noticeable that in aircraft 070 and 841 a definite increase in kill rates is traceable after the settling time was increased from 5 minutes to 30 minutes; but even here this was not effective in forming a lasting residue as evidenced by the greatly lowered kill rates on the succeeding days in the tests made before spraying. Obviously a 30 minute settling period is operationally not feasible, so that this is of academic interest only. On the whole it is concluded that the residues deposited by practical aerosol treatments (which in a C-47 would consist of 30 seconds spraying and settling - i.e., holding time of 5 minutes) are evanescent, do not build up in an aircraft in frequent operational use, and should not be relied upon.

b. Residue Treatment Materials. As directed in the "Request for Test..." (Inclosure 1, par 3 a) the preliminary phase of this project was conducted by the Air Technical Service Command. This phase was intended to insure that no materials, especially solvents for DDT, would be used that might cause damage in aircraft. The recommendations on this question received from the Air Technical Service Command were clear-cut and left no room for doubt. (See Inclosures 5-7). They are discussed below.

(1) Solutions and Emulsions. Since both these methods of applying DDT depend on the presence of a suitable solvent, tests of their suitability are really tests of various solvents. In this respect the Air Technical Service Command condemned all practical solutions, including 5% DDT in kerosene, 5% DDT in fuel oil No. 2 and 1% DDT and 2½% thanite in kerosene, the three solutions most widely issued and used by the armed services.

The recommendation that a modified freon bomb might be used for residue application was not considered practical. In the first place the deposition of a residue by aerosols is very unsatisfactory, the spray droplets tending to settle mainly on the floor and other upward-facing surfaces. Secondly, in order to obtain a sufficiently large deposition so much solvent would have to be used that the objection to solvents would again come into force. Accordingly, in view of lack of facilities at Wright Field for adequate tests, and because of the pressure of time, it was decided to try other methods rather than to pursue the question of solutions further.

Emulsions are subject to the same disadvantage as solutions, i.e., the presence of a solvent. It might be possible, by means of a quick-breaking, oil-in-water emulsion, to secure adequate deposition of DDT without solvent damage. However, it was decided that it would be preferable to try aqueous suspensions first, since the emulsion would be at best a compromise.

(2) Smoke Grenades and Candles. The E-22 smoke "candle" developed by Chemical Warfare Service as a means of distributing DDT was thoroughly tested at Wright Field by the Air Technical Service Command and a representative of Chemical Warfare Service. As will be seen from a study of the reports on this work (Inclosures 7 and 8) the results were such as to condemn this method because of the corrosive effect on metals. In addition, the danger of fire is considered a serious one. The grenades obtained from Chemical Warfare Service for testing were not consistent; about one in eight flamed, a very serious matter in an aircraft.

(3) Dispersible DDT Aqueous Suspensions. The series of tests made by the Air Technical Service Command of the suitability of various formulations of "dispersible DDT" for application in aqueous suspensions, and consolidated in Inclosure 5, showed conclusively that no damage would be done to materials of aircraft construction by the use of these formulations. Accordingly, in view of the unsuitability of DDT solutions and emulsions, and the obvious impracticability of dusts (See par b (4) below), these suspensions were chosen for further testing. The advantages of the use of aqueous suspensions are many, arising from the absence of solvents. This does away with the transportation problems; toxicity to humans; odor; staining; and danger from fire or explosion that are attendant upon the use of solvents. The chief disadvantages are: the present commercial unavailability of formulations containing more than 50% DDT; a tendency to eventually settle out of suspension; and the greater visibility of the residue deposited, a matter that is very liable to offend the sense of neatness of some personnel. (See discussion in Sec IV, par h, below).

(4) Dusts. Although the use of dusts offered a possible way of depositing a DDT residue in aircraft, this was not considered seriously enough to warrant conducting formal and lengthy tests after a number of informal tests had been carried out. The use of dusts would entail a number of disadvantages. These are: weight of the amount necessary

for each treatment (16.6 lbs of a 9% dust for each treatment of a C-47); difficulty of even applications; failure of the dust to stick to surfaces, but instead to fall to the floor; tendency of the dust to deposit very slightly on vertical surfaces and hardly at all on downward-facing surfaces; danger of clogging minute apertures of some instruments such as altimeters and oxygen apparatus; extremely messy appearance. In view of these disadvantages, of the relatively slight advantages, and of the obvious superiority of aqueous suspensions, it was decided to do no further work with dusts except as a last resort. Fortunately this did not prove necessary.

c. Spraying and Treating Equipment.

(1) "Lofstrand" Model NER 106 Knapsack Sprayer. This new issue sprayer (See Sec II, par e (1)) proved on the whole satisfactory for residual spraying in aircraft, and superior to other sprayers tried. Residual spraying demands a wet spray of relatively large droplets that will reach the surface being treated and will stick there. In this respect the Lofstrand sprayer is greatly superior to paint guns of the atomizer type. These form a relatively fine mist spray that travels under high speed; much of this spray tends to bounce from the surface and fog up the air, and eventually falls to the floor or is blown out of the aircraft. The Lofstrand sprayer is also superior to ordinary types of knapsack sprayers, and to the 3-gallon Chemical Warfare Service decontamination sprayer. These other sprayers form too coarse a spray which tends to run badly, and which, moreover, is put out in so large a volume as to make accurate spraying in an aircraft difficult or impossible.

Of the four nozzles with which the Lofstrand sprayer comes equipped only the No. 3 "Cone Spray" and No. 4 "Mist Spray" were found suitable for spraying in aircraft. The No. 2 "Flat Spray" has altogether too wide an angle for spraying in the confined quarters of the interior of an aircraft and too great an output, averaging about 400 cc per minute at 20 p s i pressure. The fan of spray put out by this nozzle tends to be irregular, giving incomplete coverage. The No. 3 "Cone Spray" really has too wide-angled a cone, and too large an output, 487 cc per minute at 20 p s i pressure, but gives better coverage and can be used advantageously for spraying in parts of the aircraft where large are to be covered quickly without the necessity of care to avoid instruments. The No. 4 "Mist Spray" nozzle, with an output of 120 cc per minute at a pressure of 20 p s i is the best of the four. It tends to give a spray that is very slightly too fine for best residual work, and to occasionally clog up, but otherwise is excellent.

It was noticed that the release valve of the Lofstrand Sprayer tended to stick open occasionally, and that the pressure gage likewise at times became jammed and had to be taken off and cleaned. Otherwise the apparatus functioned very well with the aqueous suspensions.

It was found very convenient to have an extra shut-off valve installed just beyond the release valve. This, as a matter of fact, was used more during spraying than the regular spring release valve, since it was more reliable (See Inclosure 10). The extra valve was salvaged from the de-icer tank of a C-47.

The short, angled spray-tube shown in Fig 10, Inclosure 10, was found to be practically a necessity for spraying inside aircraft. The standard spray tube is too long for proper use in such confined quarters. The angle of the short tube is highly advantageous because it permits efficient spraying under floor boards, and especially of the under surface of floorboards.

(2) Sprayer, Liquid, Insecticide, Continuous Spray, 2-quart (or 3-qt). This, the standard issue hand sprayer, was tried for suitability as a substitute residue sprayer (See Inclosure 10). Its exact output cannot be predicted, since the pressure cannot be controlled accurately; and the spray contains a considerable proportion of fine droplets which cause too much fogging in the air. Moreover its use entails a very considerable amount of labor when large surfaces are to be treated. Nevertheless, the sprayer is perfectly adequate as an emergency substitute.

(3) "Sure-Shot" High Pressure Sprayer. Although not an item of Army issue, this sprayer is in wide use by the United States Public Health Service and other governmental agencies, chiefly for pyrethrum, fine mist or sub-aerosol sprays. In the present tests it functioned well as a sprayer of dispersible DDT aqueous suspensions, being especially valuable because of its low rate of output when used at 20-30 p s i. It sprays a narrow swath, almost a necessity when attempting to treat confined spaces between and around instruments without spraying the instruments. The nozzle occasionally became plugged during spraying; but its very simple construction made it an easy task to take it apart and clean it. In other ways this sprayer gave no trouble and functioned efficiently. It is recommended for use in conjunction with a larger volume, higher output sprayer, like the "Lofstrand".

(4) Paintbrushes. As an emergency substitute for spraying, the use of any suitable, available paintbrushes is recommended. The dispersible DDT aqueous suspensions are particularly adapted for painting, because their very low rate of absorption through the skin makes them presumably much safer to humans. Painting is, however, slow, and should be used only when no suitable sprayers are available, or for special jobs around instruments where extreme care of application is necessary.

d. Spraying and Treatment Techniques. The following observations were made during the treatment of C-47, B-17 and B-25 aircraft for tests, and during incidental studies of C-45, A-26, B-24, B-29 and B-32 aircraft. They thus reflect experience with the majority of the AAF aircraft concerned with disinsectization activities. The basic principles

of treating aircraft are the same for all, but details differ with different types.

(1) Calculation of the amount of dispersible DDT formulation required should be made on the basis of an application of 100 mg of DDT per sq ft. Thus, to completely treat the interior surfaces of a C-47, calculated at 3373 sq ft, would require approximately 336 grams of pure DDT, or approximately 375 grams or 13.5 oz of a 90% formulation; this would be mixed in approximately 3.38 gal of water giving a 2.5% suspension. Similar calculations can be made for other types of aircraft. A table giving internal volumes and surface areas of a number of types is given in Inclosure 9.

(2) Preparation of the aircraft for treatment should be arranged in advance and be done by maintenance personnel. With all types of aircraft this should include the removal of such loose equipment as will interfere with thorough spray coverage or as may be damaged during treatment. Thus maps, technical orders, landing boats, bedding, tools, etc., should be removed.

In some aircraft, such as B-17's and B-25's, there are no extensive areas of flooring beneath which, and on the under side of which, spraying cannot be done without extensive preparations. Here, by using the short, angled spray-tube, spraying can be done easily. In other types, however, such as C-47 and C-54 aircraft, there are large areas of relatively tight flooring beneath which are spaces of considerable volume. It is essential that the under sides of this flooring, and all surfaces beneath it, be thoroughly treated, since experience has shown that many insects will penetrate to the space beneath even apparently tight flooring (Inclosure 3, Table 5). For this work enough flooring must be removed to permit spraying of the entire surface beneath (Inclosure 10). This should be done by the regular plane crew or by regular maintenance personnel by arrangement well prior to the spraying. In two C-47 aircraft treated during the present tests, this procedure was followed. The Flight Engineering officer in charge stated that approximately eight man-hours were employed in removing and later in putting back one strip of flooring the entire length of the cargo compartment.

It would seem to be the part of wisdom to give an extra heavy treatment to surfaces which are normally never seen by personnel riding in the plane. One reason is that this extra heavy dosage may, by serving as a reservoir from which particles of DDT may be blown about to other parts of the aircraft, help in some measure to compensate for the loss of DDT due to wiping and wear from more exposed surfaces. Another reason is that many negatively phototropic insects that tend to seek dark, sheltered places are relatively safe from aerosol treatments in such places, and that assurance of control there is therefore doubly necessary.

The noses of cargo planes, baggage or cargo compartments, or gun turrets reached from outside the plane, gun barrels, tail compartments (often normally kept locked) landing-gear nacelles and similar out-of-the-way or little used parts must be thoroughly sprayed. A mechanics stage will be necessary for spraying nose compartments. The tail may be sprayed without entering it by spraying back from the front end and forward from the rear end (Inclosure 10).

Snap-on or semi-permanently affixed fabric linings are of great importance since the spaces behind them usually offer excellent hideaway places for insects. Whenever possible the linings should be removed and not only all surfaces behind them, but the back surfaces of the linings themselves, extra heavily treated. It must be kept in mind that there are many apertures in and between these linings through which insects can easily gain entrance to the spaces behind. See Inclosure 10, fig 5.

Plexiglas can be treated and wiped clean afterward and still retain a very worthwhile toxicity; an important point since many insects contact the windows a great deal, especially under the stimulus of aerosol.

A two-man spraying team can completely treat a C-47, that is readied in advance, in 1½ hours, a B-25 in one hour and a B-17 in two hours, these times including mixing of aqueous suspensions.

e. Laboratory Tests of Residual Toxicity.

(1) Effects of Materials of Aircraft Construction. In Series A and B (Inclosure 13) the results are so arranged as to bring out the effects of the various materials on which the formulations were applied.

(a) Unwiped Samples. In the tests on unwiped samples no significant differences appeared between the painted duralumin, unpainted duralumin, plexiglas or painted wing fabric. The soft cloth linings of B-29 and B-32 aircraft showed significantly poorer results, doubtless due to absorption, although differing little from each other.

(b) Wiped Samples. Tests on the wiped samples all agreed in showing significant differences between various materials. In every case the roughest and most porous material, painted wing fabric, gave the best results and plexiglas, the poorest, with little or no significant difference between the duralumins. The soft cloth B-29 and B-32 linings retained their toxicity extremely well, showing no significant change after wiping.

(2) Effects of Various Formulations. In Series C and D (Inclosure 14) the test results are so arranged as to bring out differences between the four formulations. The differences shown are not very consistent. On the B-29 and B-32 fabric linings, Deenol 50-F gave significantly poorer results on the unwiped samples but was slightly better than average on the same samples after wiping. On the other materials it was only very slightly poorer than average. The best results were given by 6002-64 which fairly consistently gave slightly faster knockdown on most materials. On the whole, however, toxicity differences between the various formulations seem unimportant.

General toxicity held up extremely well and very encouragingly. Even after the elapse of 28 days, and the wear due to fourteen tests and two wipings with dry cloths, most of the samples were giving 100% knockdown of flies in two to three hours. It was therefore considered that figures justified the testing of these formulations in all parts of aircraft and pointed strongly to a probability that they would there give good and durable residual insect control.

(3) Tests of Formulation 6327-33B (ATSC Type M). As described in Sec II, pars d (6) and h (3) above, a series of tests was made comparing the durability of the toxicity of DDT residues of formulations 6327-33B and 6002-62. The former of these contains a relatively large amount of polyvinyl alcohol. This, it was believed, would, by acting as a binder, tend to make the residue adhere more closely and would thus make it more durable.

In Table I (Inclosure 15) are shown comparisons of 20 tests of each of the formulations at concentrations of 5 mg DDT per sq ft and 10 mg per sq ft. At this point all samples showed a very large and sudden increase of toxicity. The average time to complete knockdown at the 5 mg concentration was 41.4 minutes for 6327-33B and 43.2 minutes for 6002-62. This is only a small amount in favor of the 6327-33B. Similarly, at the 10 mg concentration, 6327-33B showed an average (51.9 min) only slightly better than that of 6002-62 (56.1 min).

In Table II (Inclosure 15) are results of 41 tests comparing residues of these formulations at concentrations of 50 mg and 100 mg DDT per sq ft. As was to be expected these greater residues showed far greater durability than those of 5 mg and 10 mg, so that even after the 41 tests, with all the attendant wear due to the large numbers of flies, toxicity was holding up excellently. Unfortunately, the tests had to be discontinued at this time. In these tests, in both 50 mg and 100 mg concentrations, the residues of 6002-62 showed slightly better results.

It is possible that if the 50 mg and 100 mg tests could have been continued to the ultimate entire loss of residual toxicity different averages would have appeared, in favor of 6327-33B. It is doubtful, however if 6327-33B would have shown very much better average results than 6002-62, in view of the results of the 5 mg and 10 mg comparisons. It is considered that the tests show that, in any event,

there is not a sufficient difference in favor of 6327-33B to overcome the handicap of this formulation, namely the reduction of its DDT content to 76.4% owing to the great increase of polyvinyl alcohol (to 16.7%) (See Inclosure 12 for details of the formulations). This is a handicap, of course, because it means that in order to deposit an equal amount of DDT, 90/76.4 times as much of 6327-33B would have to be used as of 6002-62 in which the DDT content is 90%.

(4) Effects of Wiping and Wear. Consultation of the tables of Inclosures 13 and 14 shows that, as would be expected, the effect of wiping was reflected in a much greater time to 100% knockdown. Thus on the duralumin, plexiglas and wing fabric samples the average for the first series of tests was 18.8 minutes for unwiped samples and 48.6 minutes for once-wiped samples, a ratio of 1/2.6. Then, after the unwiped samples were wiped for the first time and the once-wiped samples were wiped again, the averages for the second series of tests were 69.4 and 120.0 minutes respectively, a ratio of 1/1.7. Averaging these, there is evident a ratio of 1/2.15 for unwiped/wiped samples of these materials.

The effects of wear due to the tests are apparent in comparing the seven tests each for those samples wiped before any tests were made on them, which averaged 48.6 minutes, and those wiped once after seven tests had been made on them, which averaged 69.4 minutes. The difference between these two sets of tests, expressed by the ratio 1/1.4, represents an approximation of the effect of running seven tests, with about 25 flies per test, plus incidental wear, on one set of samples and not on the other.

The soft cloth linings of B-29 and B-32 aircraft showed surprisingly little effect of wiping and wear. As already noted, these soft cloth surfaces showed a much slower initial knockdown rate than the more impervious materials; but even after the running of seven tests and a thorough wiping there was little diminution of toxicity. This is shown by the ratios 56.5/64.4 or 1/1.13 and 54.0/55.3 or 1/1.02.

It may be broadly stated, therefore, that wiping the treated surfaces with a dry cloth tended in general to approximately double the time to 100% knockdown, i.e., to halve the toxicity of the wiped surfaces, on the chief materials of aircraft interiors. On soft cloth linings the initial toxicity was only about one-third of that on other materials, but wiping and wear affected these so little that the end result was nearly the same. Overall, the effect of wiping, even twice, was to materially reduce the residual toxicity but not, by any means, to a point of uselessness.

f. Cage Tests, Residual Toxicity in Aircraft.

(1) General Results. The large series of tests shown in Inclosure 16 demonstrate the effectiveness of all of the dispersible DDT residues applied in aircraft against both houseflies and Anopheles

mosquitoes. These tests were conducted over periods of from slightly over one month (Inclosure 21, B-17 No 042) to considerably over two months (C-47 Nos 070 and 664 and B-25 Nos 910 and 913). Since all aircraft were in frequent use during the tests (Inclosure 20) the tests represent as far as possible an evaluation of results under actual operational conditions.

The consolidation of these tests shown in Inclosure 18 shows the net total results best. It will be noted that the grand total of housefly tests shows a 24-hour kill, based on a 2-hour exposure period, of 9670/9930 flies, or 97.3% and a similar 24-hour kill of Anopheles of 3299/3299 or 100%. The grand total 24-hour kill of both Anopheles and houseflies is 13019/13229 or 98.4%. It is considered that as far as cage tests can give a true measure of actual, practical "field" conditions, these figures show the overall efficacy of the residual treatments.

Detailed examination of the tests in individual aircraft (Inclosure 16) shows, moreover, that there was no significant diminution of control during any of the test periods, evidence of the almost undiminished and continuing efficacy of the treatments. It is unfortunate that the pressure of time prevented the continuation of these tests until a clear picture could be obtained of the durability of the residues; but it is considered a safe assumption on the basis of the data presented that the treatments of 200 mg per sq ft would have remained satisfactorily efficacious for total periods of at least three months, and that of 100 mg per sq ft for a total period of at least two months.

(2) Effects of Different Formulations. Both formulations gave 100% 24-hour kill rates of Anopheles (See Inclosure 18) but Deenol 50-F gave slightly faster knockdown, an average of 31.7 minutes as compared with 34.9 minutes for formulation 6002-160. With flies, on the other hand, formulation 6002-160 gave slightly better results, in a shorter average time to complete knockdown (33.7 minutes vs 35.4 minutes), in a notably higher total knockdown rate at the end of the 2-hour contact period (97.3% vs 85.4%) and in a better overall control rate, (98.7% vs 95.7%).

It is not certain that these differences are significant, for they include tests on wiped surfaces, and there was undoubtedly some variation due to greater or lesser efficiency in wiping on various surfaces. To offset this factor a consolidation has been made of the times to complete knockdown of all cages on unwiped surfaces. This shows that Deenol gave a shorter time to 100% knockdown on flies than did 6002-160 (23.03 minutes vs 26.37 minutes) but on the other hand gave a longer time on Anopheles than 6002-160 (22.46 minutes vs 21.26 minutes) (See Inclosure 19).

The conclusion is that there was no significant difference between the toxicity results of the two formulations, both being satisfactorily efficacious in this respect.

(3) Effects of Wiping and Wear. (See Inclosure 19) The cages of houseflies on unwiped surfaces gave consistent 100% knockdown in less than two hours in all tests, whereas those on wiped surfaces, as was inevitable, gave much poorer results. Cages of Anopheles gave 100% figures in all cases. The consolidated figures of houseflies show an overall, 24-hour kill rate of 94.9% on wiped surfaces and 100% on unwiped surfaces. The demonstration that wiped surfaces give poorer results than unwiped ones is, of course, almost superfluous. The significant facts are the 100% control of Anopheles and 94.9% control of houseflies on the wiped surfaces, showing an actual retention, despite wiping, of a satisfactorily high degree of toxicity.

(4) Comparison, Anopheles and Houseflies. Contrary to experiences of some previous workers, better residual control was obtained of Anopheles than of houseflies (Inclosures 17 - 19). The consolidations shown in the tabulations contain all Anopheles tests, but, to make the comparison more effective, those of Inclosure 17 contain only those housefly tests made in the same aircraft, at the same times, and side-by-side with the Anopheles tests. They are thus as comparable as any two series of such tests could be.

The results are so obvious as to need no discussion. Only 144/164 housefly cages showed complete knockdown in less than 2 hours, and these averaged 37.1 minutes; while all 164 Anopheles cages showed complete knockdown in less than 2 hours in an average of 33.8 minutes. All housefly cages averaged a knockdown of 88.4% in 2 hours, while all Anopheles cages showed 100%. The overall 24-hour kill rates were 96.7% for houseflies, compared with 100% for Anopheles.

Study of the figures shown in Inclosure 19 of the average times to 100% knockdown in cages on unwiped surfaces alone shows, similarly an average of 24.7 minutes for houseflies and of 21.86 minutes for Anopheles, clearly a faster control of the latter.

g. Free-Flight Tests of Residual Toxicity in Aircraft. The "free-flight" tests, which were made during the latter part of the testing period, are even more indicative than the long series of cage tests of the potency of the residual treatments given the aircraft. It was originally intended, for the purpose of accumulating exact data, to collect all flies from the planes at the end of the tests, but this proved not only impractical but, in the light of the results, unnecessary. The results were extremely striking and are hardly shown by the figures on the tests (Inclosures 22 and 23); for in recording the results many flies were not recorded as "knocked down" that were to the experienced observer, really so affected by the DDT that there was no room for doubt that they would never recover.

(1) Twenty tests were made in aircraft on the ground (Inclosure 22), using approximately 90,000 houseflies. In nineteen of these, complete knockdown was obtained in less than 2 hours, the average being 67.9 minutes. In the single other test a few flies were still able to fly at

the end of the 2 hour period, but these all died within 6 hours after being collected and placed in holding cages.

The tests in the B-17, serial no. 042, were of particular interest, since this aircraft had received only approximately half (100 mg DDT per sq ft) the residual treatment that the others had. Results were excellent, the average time to complete knockdown for the four tests being 60 minutes; the last test, in which there was complete knockdown in 45 minutes, was run nearly five weeks after the treatment.

(2) Only one test per aircraft could be made in actual flight (Inclosure 23). These tests were, moreover, made at temperatures considerably below those at which the ground tests were made. As a result of this the flies did not move around as much, but tended to remain in one place a large part of the time. When this place happened to be an instrument, piece of cargo or baggage, that had received no residual treatment, such flies naturally contacted little DDT. However, it will be noted that the longest time to complete knockdown in any test was 1 hour and 45 minutes, and the average of this for all tests was 87.5 minutes.

(3) It is believed that the conclusion is fully warranted that these aerial free-flight tests and those made on the ground fully demonstrate the practical and durable efficiency of the residual treatments given these aircraft.

h. Suitability of Dispersible DDT Residual Treatments.

(1) Advantages of Dispersible DDT. Summarizing the results of the work done with dispersible DDT in aircraft, the following advantages of using dispersible DDT in aqueous suspensions appear:

(a) Safety to Personnel. Aqueous suspensions are presumably much less toxic than solutions because of the certainly lowered (or possibly non-existent) rate of absorption through the skin. They are definitely less irritating to the skin and nasopharyngeal mucosa because of the absence of solvents; and may be presumed to be less toxic on inhalation.

(b) Safety to Materials. Aqueous suspensions have been shown to have no deleterious effects on the materials of aircraft and instrument construction, while all solvents tested were found to be harmful in this respect. The use of the suspensions is not attended by the danger of fire or explosion that exists when any practical DDT solvent is used.

(c) Cost and Logistics. While at present the cost of dispersible DDT preparations appears to be approximately the same as that of solutions containing equal

amounts of DDT, the decreased expense of packing, shipping and storing due to the absence of liquids is a very important logistical consideration. The absence of solvents also may be expected to cause less deterioration of spraying equipment.

(d) Durability. Unfortunately neither time nor the scope of the project authorization permitted detailed comparison of the durability of solution and suspension residues. Some work now being carried on in another project appears to show, however, that aqueous suspension residues are definitely much more enduring. In part this is due to the presence in suspension formulations of binding agents such as polyvinyl alcohol; and in part it is due to the apparently greater tendency of solutions to soak into some surfaces (such as painted ones) and thus to carry part of the DDT away from the outer surface where alone it is of value.

(2) Disadvantages of Dispersible DDT.

(a) Availability. At present only two formulations of dispersible DDT are available commercially, Deenol 50-F manufactured by the E. I. DuPont de Namours Co., Inc., and Neocid Barn Spray, a product of the Geigy Company. Deenol contains 50% DDT and Neocid 40%. It is considered that neither of these is entirely satisfactory, but that of the two the Deenol is preferable.

Various tests made during the course of this project have shown that nearly all of the 90% or more formulations have at least as good toxicity and durability as Deenol and Neocid, are superior in suspension stability, and are preferable because of their much lesser weights per unit of DDT. In another project on DDT suspensions now in progress one of these formulations (6002-163B) is being tested very extensively and for this work no difficulty was encountered in securing this formulation in very large quantities from the DuPont Company. It therefore seems certain that, if there is demand, any of the other formulations can quickly be made available commercially too. In the interim Deenol 50-F is adequate.

(b) Spraying Difficulties. The fact that any aqueous suspension will in time settle may be a handicap, for it necessitates fresh mixing of suspensions not too long before use, and a certain degree of agitation during use. All suspension formulations tested, moreover, give a certain amount of foaming when mixed with water.

These, however, have proved in actual use for aircraft treatment to be relatively unimportant handicaps. They are all, moreover, capable of partial or entire elimination with further research on new formulations.

A more serious difficulty is sometimes caused by the tendency of suspensions to clog in fine nozzles. This, again, however, has not proven very serious in actual practice, even with the very fine nozzle openings of the "Sure-shot" sprayer (See Sec IV, par 3 (c) above).

(c) Appearance of Residue. The most serious objection to the use of dispersible DDT in aircraft arises from the fact that the residue, even in the same concentration, is very much more noticeable than that of solutions, forming a distinct whitish deposit (See Inclosure 10 figs 1 & 2). This is objectionable on the grounds of appearance, especially in aircraft where cleanliness and polish are important items. No way has been found to eliminate this. Even in concentrations of as low as 50 mg per sq ft the residue is plainly visible. By the addition of a small amount of pigment the residue might be made to match the surface on which it is applied, a possibility especially worthwhile for commercial airlines where appearance of the aircraft is a matter of primary importance.

The tests on surfaces which had been wiped apparently clean of residue with a dry cloth showed, however, that although considerable of the toxicity is lost, sufficient remains to give a very useful control (Sec IV par e (3) and f (3)). This enables the recommendation that the entire interior surface of the aircraft be sprayed, including all windows, and that those surfaces on which the appearance of the residue is obnoxious be then wiped with a dry cloth after the spray has been allowed to dry on. This will not, of course, give as good control of positively phototropic (i.e. "tending to move toward the light") insects as if the surfaces were left unwiped; but it will be far better than no treatment at all. Since the dark places, where the appearance of the residue is of no moment, will remain unwiped, negatively phototropic (i.e. "shunning the light") insects will receive the full effect of the treatment.

The above is a compromise which will not give the full value of the residual treatment, but it is realized that this compromise must be made. And the tests here

reported upon show that, even with extensive wiping and wear, good insect control is possible. Since solution and emulsion sprays are ruled out, and since it is realized that objection to the appearance of the suspension residues will be strong, and also justified, it is felt that this compromise, permitting wiping, is the only recourse.

It is possible that in the future some way may be found to apply a DDT residue from water suspension that will not be as noticeable as those at present.

(3) Summary. Aqueous suspensions of dispersible DDT are safer for use in spraying the interiors of aircraft, both to personnel, and to the materials of the aircraft and instruments. They cause no fire and explosion hazards. Their use probably will, in the end, prove cheaper than use of solutions or emulsions. They have as great toxicity as solution and emulsion residues; and this toxicity may be much more durable.

On the other hand 90% DDT suspension formulations are not at present available commercially, although they can easily be made so. They occasionally cause slight difficulties due to sprayer clogging or to settling out of suspension. Their residues are much more noticeable than those of solutions and emulsions, and will be objected to on this ground. However, if applied and allowed to dry on, and then wiped with a dry cloth, they still retain a residual toxicity sufficient to give 90 to 95% housefly kill for a month or more. Their use in this way is therefore recommended.

i. The Scope of Aircraft Disinsectization; Summaries.

(1) Treatments. It has been shown that both DDT aerosol and DDT residue treatments are practicable for use in aircraft. It has also been shown, however, that neither type of treatment should be relied upon alone for safe disinsectization.

(a) Aerosol. If the aerosol alone were used, even with perfect conditions and application, the dosage necessary to secure sure control of even houseflies would be so heavy as to awaken strong objections from personnel in the aircraft, and would probably cause frequent evasions of regulations, with resulting lack of insect control. An aerosol dosage sufficient to give sure control of economic pest insects would have to be so massive as to be entirely impractical.

(b) Residual. A thorough residual treatment of 100 mg of DDT per square foot will give efficient control of most insects on the average long flight and may be relied upon to last at least a month in aircraft in average operational use. However, aqueous suspension

residues, which are the only type safe or practical for use in aircraft, are quite noticeable in appearance and bring forth strong objections on this ground. When applied, dried and wiped off, they still give a good, but not fully adequate toxicity on the wiped surfaces. Residues, moreover, may be of little or no value against insects resting on passengers, cargo or baggage, unsprayed instruments, etc.

(c) Summary. It is therefore concluded that both DDT pyrethrum aerosol and DDT aqueous suspension residue treatments must be used together to supplement each other. The aerosol dosage may then be somewhat lower than if it, alone were being relied upon. The residue treatment may be wiped, after drying on, from areas where its appearance is objectionable, but should be left in full strength wherever possible.

(2) Insects Concerned.

(a) Disease Vectors. The chief emphasis in aircraft disinsectization has usually been placed on insect disease vectors. In part this is due to the increased importance of Army, Navy and U. S. Public Health programs during wartime, and to the fact that, for the first time, millions of Americans have been subjected to contact with tropical diseases carried by insects. In this respect it is noteworthy that the International Quarantine Commission was composed of one officer from each of the above-mentioned Services, but included nobody versed in the problems of economic pest insect work. In part, also, this emphasis has been caused by a lack of full realization of the importance to the national economy of economic pest insect control, and a lack of adequate appreciation of the potentialities of damage from the importation of exotic species.

It is essential that there be no minimizing of the possibilities of importation of insect disease vectors, even though a surprisingly large part of a recent, important article on this subject has shown this attitude (i.e. Magath, T. B. and P. T. Knies; Modern Concepts of International Quarantine with Special Reference to Military Traffic; The Military Surgeon, March 1945, Vol 96 p 209-222).

It is very well to argue plausibly that Anopheles albimanus probably could not support itself if introduced into Florida; that Aedes aegypti is seldom recovered from aircraft and therefore probably seldom

enters them; that "natural barriers" will probably prevent the successful establishment of many other Anopheles even if they should be introduced; that really very few insects enter aircraft, anyway, and that, if they do, so-called "antibiotic" effects of flight never demonstrated to exist are important in preventing their survival to reproduce. It must be admitted that there is something to be said for this attitude, and there is no doubt that fear of insect vector introduction by aircraft can become exaggerated. But when one considers the facts of what did happen when Anopheles gambiae was introduced into Brazil (almost certainly not by aircraft), one cannot help feeling that it is better to lean backward to prevent any possible similar occurrences. The plain fact is that so little is known about the ecological requirements of any insect vector, even the best known, that speculation about its chances of survival in any reasonably possible region, and its ecological requirements, is not only futile but a bit dangerous.

In connection with the statement that mosquitoes do not regularly enter aircraft in numbers reference should be made to the photograph in Inclosure 24, fig 1. This shows the mosquitoes collected at Pinecastle AAF, Florida from the two side blisters alone of the gunnery-control compartment of one B-29 aircraft, after a single, massive, aerosol treatment. It is estimated that 7500 mosquitoes were collected here, and that at least as many more were in the other parts of the aircraft. The mosquitoes were so abundant in this and other aircraft parked on the field overnight that flights of some aircraft actually were seriously delayed or cancelled. Some members of the plane crews were almost incapacitated by the large numbers of bites received. The majority of the mosquitoes were Psorophora confinnis, but numbers of Psorophora ciliata, and Anopheles crucians and a few Anopheles quadrimaculatus were present.

Also in this connection reference should be made to the selected excerpts from a report on a study of disinsectization work made in the Caribbean region and Brazil by the writer of this report. These are given in Inclosure 24.

(b) Economic Pests. Possibilities of the airborne importation of economic insect pests, as noted above, have been somewhat neglected. To some degree this has been due to the necessarily great emphasis placed on guarding against importations of such insects in

immature stages, in infected plant materials, soils, etc. The fact remains that the importation of even one fertilized female of nearly any species is a very potential danger. The entomologist knows too well the almost explosive speed with which some imported species have multiplied and spread when freed from the ecological restraints of their native homes. He knows that it is dangerous in the extreme to speculate on which foreign species, if introduced, might thus become a serious pest; for some species, apparently innocuous in their native habitats, have become extremely serious pests when introduced abroad. And he knows by sad and very expensive experience, that, once introduced, the chances of the success of efficient man-made limitations to the spread of a major pest are extremely poor.

There is only one safe generalization: any insect introduced into a strange environment, and freed from the natural, biological and physical controls of its native habitat, may change unexpectedly into an economic menace, impossible to limit or control. This may seem to be an extremist viewpoint. It may be true that of the hundreds of species of insects introduced into this country, not nearly all have turned out to be really serious pests. Nevertheless, when one considers the procession of foreign insect pests, from the Hessian Fly and the Codling Moth to the European Corn Borer and the Japanese Beetle, to name only four species that have cost uncounted millions of dollars, one realizes that it is indeed imperative to take every precaution. And the first echelon of defense against such pests consists of the establishment and strict enforcement of quarantine and disinsectization regulations.

(c) Summary. Until adequate data are available, speculations tending to minimize the dangers of aircraft introduction of insect disease vectors or economic pest should not be allowed to influence the establishment and enforcement of adequate quarantine and disinsectization regulations. Greater emphasis should be placed on disinsectization for the control of potential economic pests, many of which are far more resistent to DDT than mosquitoes. Mosquitoes, among the easiest of insects to control with DDT, should not be used as a yardstick in deciding upon disinsectization procedures.

j. Revision and Enforcement of Disinsectization Regulations. As a crystallization of the conclusions reached in this work and of the

recommendations based on them a proposed revision of pertinent parts of AAF Regulation 61-3 has been prepared (Inclosure 26). In this such changes and additions have been made as seem justified by the work here reported.

(1) Revision of Regulation. The following represent the chief changes and additions made, and the reasons therefor:

(a) Full directions have been given for the technique of aerosol treatment. These are extremely important, since it has been shown that even comparatively minor variations from the optimum methods have disproportionately large effects in reducing the success of the treatment.

Of special importance here is the provision that the aerosol treatment must be given on the ground with engines not operating. The idea that the aerosol treatment is fully effective when given during flight is a particularly persistent and pernicious one which must be eradicated.

(b) The required aerosol dosage has been markedly reduced from that recommended in the preliminary report (See Sec II par b) although it represents an increase over that required by AAF Regulation 61-3, dated 9 August 1944. This reduction, it must be stressed, is conditional upon the maintenance in the aircraft of a proper DDT residue. If there is no such residue present at least three (3) times the present recommended dosage should be given. It is extremely dubious, however, if even this heavy dosage would be adequate; and it would certainly be extremely uncomfortable for personnel in the aircraft.

(c) Authorization and directions for the application and maintenance of a sufficient residual treatment are given in as great detail as possible, although the directions are somewhat limited by the fact that there is, as yet, no official issue "dispersible DDT". Therefore the exact amounts of this to be used cannot be stated until a formulation has been decided upon.

It has been suggested that the directions for application of the residue treatment should be incorporated in an AAF Technical Order, instead of being included in this regulation as an appendix. This suggestion is more or less in line with regular procedure except that the essential information is so short that the issuance for it of a separate T. O. would be wasteful. Moreover, keeping the directions as a part of the

regulation will insure that the full information necessary will always be available from a single source.

It is of the greatest importance that the renewal of the residual treatment be given sufficiently often. There being no practical way of accurately testing the efficacy of the remaining residue at any time, it is necessary that some arbitrary period for renewal be chosen. Moreover, this treatment, if tied in with one of the regular, periodic inspections, is much more likely to be given properly. The concentration of the residue has been recommended to be approximately 100 mg per square foot, only half that recommended for usual DDT residue applications, in order to avoid as much as possible the unsightliness of the residue. This makes the 100-hour check about the right time for renewal of the residue.

(d) Certain deletions have been made from par 14 of the Regulation of the names of places from which disinsection will not be required. These deleted places are: Bahamas; Curacao and Aruba; Bermuda; St. Thomas, V. I.; and Mexico, Federal District. It is the opinion of the writer of this report that sufficiently great possibility exists of the introduction from these places into the Continental U. S. of economic pest insects to warrant their deletion, whatever may be the situation regarding insect disease vectors. It is recommended most strongly, however, that in this respect consultation be had with the appropriate authorities of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

(e) The preferable term "disinsection" has been substituted for "disinsectization".

(2) Enforcement of Regulations. While the entirely unofficial statements and the relatively few observations recorded in the notes in Inclosure 24 do not by any means constitute adequate evidence, they do agree with a great number of statements, reports and rumors that have been accumulated from many sources during the work on the present project. They are borne out by the almost universal attitude of flying personnel, who regard disinsection as a nuisance and seldom take it seriously.

It is noteworthy, however, that a strict enforcement of AAF Regulation 61-3 appears to have occurred at times and places where the will was present. From the observations of the writer it appears that Natal, Brazil has been one of these places - a fortunate matter, since Natal is a key point. There the interest and will of the Medical Department, the excellent cooperation of Air Corps personnel and the presence

of Brazilian government representatives combined to produce a good disinsection situation and consistent enforcement of regulations. The Brazilian Decree Law on the subject (Inclosure 25 No 7) provides for the assessment of a fine against the pilot of any offending aircraft; and this fine has been levied more than once, with salutary effects.

Of great importance, it is believed, are the possibilities of educating Air Corps and other personnel concerned with disinsection procedures. It could not fail to be of great benefit if, by means of posters and textual material there could be presented the salient facts of the necessity for disinsection of aircraft. The names and importance of the chief disease vectors that might be introduced into this country, and concrete illustrations of the damage that has been done in various parts of the country by the chief, imported economic pest insects are items that should be included in such a program. The majority of personnel are almost completely ignorant of the overwhelming preponderance of imported insects among the major pests that cause annual losses of many millions of dollars to the people of the United States.

k. Insect Control on Airports. The matter of controlling insects in general on Army airports has been either ignored or more or less taken for granted, probably under the assumption that all necessary measures will be accomplished by the usual agencies concerned with protecting the personnel on the post. To this should now be added a new emphasis, namely controlling insects as to prevent, as much as possible, their entry into aircraft. This is obviously the first line of defense in the battle to prevent the transportation and introduction by air of exotic insects.

(1) Obviously there must be rigid control of insect breeding, both on and near all places where aircraft may be parked. Following the viewpoint that it is necessary to pay attention to economic pests as well as disease vectors, stress should be laid on the prompt detection and immediate control of outbreaks of such insects.

(2) The cultivation of crops on airports should be prohibited, since such cultivated areas can serve as foci of infection. If it is essential, for some unusual reason, that such cultivation take place, it should be so located as to minimize the danger of insects from it reaching aircraft parking areas.

(3) Every possible effort should be made to discourage civilian crop cultivation in the close vicinity of airports, or at least in the vicinity of aircraft parking areas. This may, of course, be an extremely difficult matter, since the Army may at times have little, if any, influence on the course of civilian affairs. A recommended substitute proceeding is the location of aircraft parking places as far as possible from the edges of airports and civilian crop cultivation.

(4) Miscellaneous vegetation on airports should be controlled. It must be remembered that, entirely aside from the specific types of vegetation on which economic pests feed, any thick area of plant cover

will serve as a harbor or shelter in which abnormally large numbers of insects will congregate. This congregation is especially marked during periods of strong winds, when such areas of plant cover often come to harbor relatively enormous concentrations of insects, some of them blown in from many miles away. It is obvious that aircraft parked close to such areas will, themselves, offer excellent wind shelters, and will inevitably accumulate abnormally large numbers of insects.

(5) The function of plant cover on airfields in preventing soil erosion both by wind and by water, is an essential one that must be maintained. However the grasses, which form the best of such anti-erosion covers, are relatively unattractive to most insects. This is especially true when the grass is kept closely mowed, which should always be the case anyway.

(6) Parked aircraft, especially those in transit, should be located as far as possible from all areas of vegetation except, of course, when a tactical situation in wartime demands otherwise. Wide, concrete aprons in front of hangars and operations buildings are best.

(7) Parked aircraft should as much as is practical, be kept closed up. It is realized that parked aircraft standing in the sun become extremely hot at best, and that when personnel are working in them conditions would usually be insufferable if all doors, hatches, windows and portholes were closed. This, however, should be done whenever practicable.

(8) Parked aircraft should never be left at night with interior lights burning, especially if not tightly closed.

(9) The above recommendations especially Nos (1) - (6) are equally applicable at airports of entry, to which exotic insects may be brought. It is obviously an important factor that the environment into which an exotic insect may be imported should be such as to offer it as little chance as possible of survival either for itself, or for its offspring. The plant cover on airports of entry, then, should be as simple (chiefly lawn grasses) and closely mowed as possible, and should, above all, contain no areas of agricultural crops within a half mile to a mile radius.

(10) Since mosquitoes breed in water, the ditches at all airports should be especially carefully planned and maintained so as to offer no potential breeding places within range of aircraft. Ponds and swamps should receive extra heavy and extra frequent larvicidal treatments. Strict preventive measures should be taken regarding artificial containers, in which some important mosquito vectors of disease breed.

(11) All airports concerned with traffic where disinsection is routinely necessary should receive special, regular insecticidal treatments. In this respect the aerial spraying of DDT solutions or suspensions had been proven both practical and of great value. The easily

installed apparatus for such small, liaison-type aircraft as the L-5 would be extremely valuable in airport insect control, and should be made available to all regular airports of entry.

V. RECOMMENDATIONS.

a. Revision of Regulations. It is recommended that this report be considered by the Quarantine Liaison Officers of the United States Public Health Service, the United States Navy, and the United States Army as a basis for additions to, and revision of, the existing regulations on disinsectization of aircraft of the above-mentioned Departments.

(1) It is recommended that the above Quarantine Liaison Officers invite to join them in their considerations a representative of the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

b. Revision of AAF Regulation. It is recommended that Sec IV of AAF Regulation No 61-3, dated 9 August 1944, be revised as soon as practicable. In this revision there should be included provision calling both for increased, improved aerosol treatment of aircraft, and also for periodic DDT residual treatments of the interiors of aircraft with aqueous suspensions. A recommended revision of this regulation is appended as Inclosure 26.

c. Supply. It is recommended that research be initiated, at a suitable AAF installation under the Air Technical Service Command, to develop and recommend for AAF use an improved, dispersible DDT formulation. This should include a much higher percentage of DDT than either Neocid Barn Spray (Geigy Company) or Deenol 50-F (E. I. DuPont de Nemours, Inc.).

(1) It is recommended that, as soon as possible and in the interim before the development and procurement of the above improved formulation, adequate supplies of DuPont Deenol 50-F be obtained and made available, at AAF installations and other points where necessary, for aircraft disinsectization.

(2) It is recommended that steps be taken immediately to issue the Lofstrand Model NER 106 Sprayer (Corps of Engineers Supply "Sprayer, insect, knapsack-type, plunger-type, cylindrical-shape, 3-gallon capacity, Stock No 41-7839.400.030") to all necessary AAF installations for aircraft disinsectization.

(a) It is recommended that a short, angled spray-tube as illustrated in this report be added to the equipment of this sprayer for aircraft disinsectization.

(3) It is recommended that consideration be given to the establishment of the "Sure-shot" High Pressure Sprayer (Milwaukee Sprayer Mfg., Co., Inc., Milwaukee, Wis.) as an item of Air Force issue for

aircraft disinsectization and other insect spraying.

d. Education. It is recommended that an AAF educational program instituted immediately to acquaint all AAF personnel with the reasons for aircraft disinsectization.

VI. INCLOSURES:

a. Inclosure 1 - Letter, subject: "Request for Test - AAF Board Project No J-4671 - 'Disinsectization of Aircraft, Using DDT'", dated May 25, 1945.

b. Inclosure 2 - Summary, Wire-Screen Cage Evaluation Tests.

c. Inclosure 3 - Tabulations, Free-Flight DDT Aerosol Tests in Aircraft on Ground.

d. Inclosure 4 - Tabulation, DDT Aerosol Residue Deposition Tests in Aircraft.

e. Inclosure 5 - Army Air Forces, Air Technical Service Command, Engineering Division, Memorandum Report on "Effect of DDT on the Materials of Aircraft Construction", dated 10 January 1946.

f. Inclosure 6 - Army Air Forces, Headquarters Air Technical Service Command, Preliminary Report, subject: "Effect of DDT on the Materials of Aircraft Construction", dated 4 August 1945.

g. Inclosure 7 - Army Air Forces, Headquarters Air Technical Service Command, Preliminary Report, subject: "Effect of DDT Smoke Grenades on Aircraft Materials", dated 18 July 1945.

h. Inclosure 8 - Army Service Forces, Office Chief of Chemical Warfare Service, Letter and Report, subject: "Preliminary Tests on DDT Grenades by the Air Technical Service Command, Wright Field, Ohio", dated 21 July 1945.

i. Inclosure 9 - Letter and Indorsement, subject: "Internal Volume and Internal Surface Area Data", dated 29 May 1945.

j. Inclosure 10 - Photographs of Spraying Dispersible DDT in Aircraft.

k. Inclosure 11 - Photographs of Laboratory Residual Toxicity Tests.

l. Inclosure 12 - List of Dispersible DDT Formulations Used in Tests.

m. Inclosure 13 - Tests of Dispersible DDT Aqueous Suspension Residues on Various Aircraft Materials. Tests of Durability on Various Materials.

n. Inclosure 14 - Tests of Dispersible DDT Aqueous Suspension Residues on various aircraft Materials. Tests of the Comparative Durability of Various Formulations.

o. Inclosure 15 - Comparison Tests, Dispersible DDT Formulations 6002-62 and 6327-33B (ATSC Type M).

p. Inclosure 16 - Consolidations of Residual Toxicity Cage Tests in Treated Aircraft.

1. C-47, 070, Tests with Houseflies
2. C-47, 070, Tests with Anopheles
3. C-47, 664, Tests with Houseflies
4. C-47, 664, Tests with Anopheles
5. B-25, 910, Tests with Houseflies
6. B-25, 910, Tests with Anopheles
7. B-25, 913, Tests with Houseflies
8. B-25, 913, Tests with Anopheles
9. B-17, 042, Tests with Houseflies
10. B-17, 738, Tests with Houseflies
11. B-17, 738, Tests with Anopheles
12. B-17, 993, Tests with Houseflies
13. B-17, 993, Tests with Anopheles

q. Inclosure 17 - Comparison, 2 Hour Knockdown (KD) and 24 Hour Kill Rates, 16 Tests, Houseflies and Anopheles Quadrimaculatus.

r. Inclosure 18 - Consolidation of Residual Tests, in Aircraft, Comparing Formulations 6002-160 and DuPont Deenol 50-F.

s. Inclosure 19 - Various Consolidations, Residual Toxicity Cage Tests in Aircraft.

t. Inclosure 20 - Flight Logs of Aircraft Used in Residue Tests.

u. Inclosure 21 - Record of Dispersible DDT Residue Tests in Aircraft.

v. Inclosure 22 - Consolidations, Free-Flight Tests in Residual-Treated Aircraft on Ground.

w. Inclosure 23 - Free-Flight Tests in DDT Residue Treated Aircraft, in Flight.

x. Inclosure 24 - Miscellaneous Field Data on Disinsectization.

y. Inclosure 25 - Various Local AF and Governmental Regulations on Disinsectization.

1. Memorandum No. 64, Hq, Antilles Department, subject:

"SECTION I, DISINSECTIZATION PROCEDURES," dated 28 June 1944.

2. Memorandum No. 83, Hq, USAAFSA, subject: "Disinsectization of Aircraft," dated 12 November 1943.

3. Circular No. 11-2, Hq US Army Forces, APO #604, c/o Postmaster, Miami, Florida, subject: "Standard Operating Procedures for Disinsectization of Aircraft," dated 28 September 1943.

4. (Instructions to Pilots) 1254th AAFBU, North African Division, ATC, (no date).

5. Division Regulations No. 25-2, Hq, South Atlantic Division, ATC, subject: "FLYING, Disinsectization and Quarantine," dated 10 June 1945.

6. SOPAC Confidential Letter #9-44, South Pacific Area and Force, Hq.of the Commander, subject: "Prevention of Dissemination of Disease-Carrying Mosquitoes by Aircraft, Responsibility for," dated 10 November 1944.

7. (Translation) Decree-Law 5.181 of January 11, 1943, "Diario Oficial" January 13, 1943, Estados Unidos do Brazil.

8. Selected Bibliography, Publications and Manuscripts Dealing with Aircraft Disinsectization.

z. Inclosure 26 - Proposed Revision, Section IV, subject: "Disinsectization of Aircraft," AAF Regulation 61-3, dated 9 August 1944.

PREPARED BY:

/s/ ALEXANDER B. KLOTS
/t/ ALEXANDER B. KLOTS
Captain, Sanitary Corps
AAFCADI Project Officer

CONCURRED IN BY:

/s/ JOSEPH B. GOLDSMITH
/t/ JOSEPH B. GOLDSMITH
Major, Sanitary Corps
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DuPont Experimental Station, Wilmington, Delaware, Office of Scientific Research and Development:

Dr. G. D. Patterson

THE ARMY AIR FORCES BOARD
Office of the President
Orlando, Florida JAR/kk-J

May 25, 1945

SUBJECT: Request for Test - AAF Board Project No. J4671
"Disinsectization of Aircraft, Using DDT"

TO: Commanding General
Army Air Forces Tactical Center
Orlando, Florida

Attn: Director of Operations

1. The object of this project is to determine the most suitable methods of disinsectization, by DDT and other agents, of aircraft departing from areas infested with pest and disease-bearing insects.

2. The equipment to be utilized in this project is of a type customarily used in studies of this type:

a. Cages for retaining insects to determine effectiveness of insecticides.

b. Spray assembly consisting of compressor, tanks, tubing and nozzles.

c. Duster, Powder, Insecticide (QM Model).

d. Smoke and aerosol bombs.

e. Hand dispensers and spray guns.

3. The information required for this project will be obtained as follows:

a. Preliminary: In order to assure that no damage will be done to aircraft, aircraft installations and instruments, the Air Technical Service Command will be requested to furnish information on the possible effects of the insecticides and solvents on aircraft, aircraft installations and instruments. This phase will be conducted directly between the AAF Board and the Air Technical Service Command although the AFTAC project officer and other personnel are invited to participate.

b. Main Test Phases

(1) Ground Phase - Simultaneously with the obtaining of

the information listed in paragraph a. above, it is desired that disinsectizing operations be conducted in the war weary or Class 26 aircraft. Observations on the safety and efficiency of the disinsectizing operations are to be made.

(2) Aerial Phase - If the preliminary and ground phases indicate the safety of disinsectization procedures, the aerial phase will be undertaken. Initially in this phase, limited areas of the interiors of operational aircraft are to be treated for residual action of DDT and by other insecticidal means. If the safety and suitability of the method became established, entire operational aircraft can be treated.

c. Final Phase - It is desired that all necessary information be obtained as a result of phases outlined in paragraph a. and b. above. If, however, this proves not to be the case, a final phase can be conducted at a continental aerial port of embarkation and debarkation to finally test disinsectization procedures.

4. As a result of tests outlined above, it is requested that information on the following subjects be obtained.

a. The safety of disinsectization procedure to personnel, instruments and aircraft parts.

b. Feasibility and effectiveness of various aircraft disinsectizing operations.

c. Supplies and equipment recommended for safe and effective disinsectization of aircraft.

d. Dosage of insecticidal agents required.

e. Frequency with which such methods should be employed.

5. The priority of this project is first. The classification is "Secret".

6. It is believed a period of four (4) months should suffice for completion of tests required in this project.

7. The AAF Board Project Officer for this project is Lt. Col. J. A. Roth, Telephone Extension 1880, Station 58. The deputy project officer is Captain Gordon Weinberg, same telephone extensions.

8. The equipment to be utilised in this project is standard equipment. If need for additional supplies and equipment is required, they can be obtained through the AAF Board project officer.

9. It is requested that this project be assigned to the DDT section of the Office of the Surgeon, AFTAC.

10. Coordination with other agencies can be accomplished through the AAF Board project officer.

FOR THE PRESIDENT:

/s/ W. W. Momyer,
WM. W. MOMYER,
Colonel, Air Corps,
Executive

J 4671

1st W/Ind

Hq, AAF Tactical Center, Orlando, Fla, 28 May 1945

To: Surgeon, AFTAC, Orlando, Fla.

1. Forwarded for your information and compliance in accordance with AFTAC Regulation #55-10 dated 14 May 1945.

2. All equipment will be obtained thru normal channels.

3. All flights will be requested thru Project Section, Operations Branch, AFTAC.

/s/ R. W. Swans, Col., AC,
for ALAN D. CLARK,
Colonel, Air Corps,
Director of Operations
and Training

Incl. 1

Incl. 2

SUMMARY, WIRE-SCREEN CAGE EVALUATION TESTS

TEST NO.	LOCATION OF TEST SLIDES	NO, OF SLIDES	NO. AREAS COUNTED	TOTAL * DMI	AVERAGE DMI PER AREA	RATIOS
1	Inside cages	4	40	6050	151.25	1
	In open	4	40	43915	1097.8	7.2
2	Inside cages	8	80	115460	1443.25	1
	In open	8	80	201666	2520.8	1.7
3	Inside cages	4	103	17849	173.3	1
	In open	4	102	46762	458.4	2.6
TOTALS	Inside cages	16	223	139359	1767.8	1
	In open	16	222	292343	4077.0	2.3

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Notes and Data

Tests: Each test in a different chamber.
Areas: Diameter of area 0.485 mm.
Aerosol Dispenser: Westinghouse DDT Lot No. 2
*DMI: "Droplet Mass Index"; the total of the cubed radii, measured in micra, of all droplets in the areas surveyed.
Ratio: Deposition of aerosol inside cages to deposition of aerosol outside cages 1/2.1.

FREE-FLIGHT DDT AEROSOL TEST
AIRCRAFT ON GROUND

AIRCRAFT: B-17G

DISPENSER: Westinghouse DDT Lot No. 2

ENGINES OF AIRCRAFT: Not operating

DOSAGE: 90 seconds, distributed throughout entire aircraft

HOLDING TIME: 5 minutes

RELEASE OF INSECTS: Throughout entire aircraft

TEST INSECT	NO. RELEASED	*% RECOVERY	24 HR NET MORTALITY
Colorado Potato Beetle Leptinotarsa 10-maculata	300	62.6	12.2%
Weevil Eudiagogus sp.	100	40.0	15.0%
Jumping Sumac Beetle Blepharida rhois	100	50.0	80.0%
Stinkbug Mormidea pictiventris	40	37.5	60.0%

* A special watch was kept for insects escaping from the plane. Before the aerosol spray was liberated 14 Leptinotarsa, 3 Eudiagogus and 2 Blepharida had escaped and were collected from the ground. Most of these came through the bomb-bay hinges and the space around the ball turret.

By the end of the 2-hour period spent in collecting insects the following additional specimens were collected from outside the plane:

Leptinotarsa	14 collected, 1 escaped and flew off, 2 accidentally killed in capture.
Eudiagogus	4 collected
Blepharida	4 collected

All these specimens collected while escaping were held for 24 hours to record the 24 hour mortality. The summarization follows:

TEST INSECT	NO RELEASED	NO. RECOVERED ESCAPING	% OF ESCAPE	24 HR MORTALITY OF RECOVERED ESCAPERS
Leptinotarsa	300	31	10.3	7.1%
Eudiagogus	100	7	7.0	0.0%
Blepharida	100	6	6.0	0.0%
Mormidea	40	0	0.0	0.0%

FREE-FLIGHT DDT AEROSOL TEST
AIR CRAFT ON GROUND

AIRCRAFT: B-17G

DISPENSER: Westinghouse DDT Lot No. 2

ENGINES OF AIRCRAFT: Not operating

DOSAGE: 90 seconds discharge

HOLDING TIME: 5 minutes

RELEASE OF INSECTS: throughout entire aircraft

TEST INSECT	NO. RELEASED	% RECOVERY	24 HR NET MORTALITY
Colorado Potato Beetle Leptinotarsa 10-lineata	250	38	16%
Weevil Eudiagogus sp.	150	11	31%
Jumping Sumac Beetle Blepharida rhois	100	29	43%
Southern Green Stinkbug Nezara Viridula	10	50	0%

Incl. 3, Table 2

FREE-FLIGHT DDT AEROSOL TEST
AIRCRAFT ON GROUND

AIRCRAFT: C-47

DISPENSER: Westinghouse DDT Lot No. 2

ENGINES OF AIRCRAFT: Not operating

DOSAGES: Indicated below with names of insects used in tests, dosage released throughout entire aircraft.

HOLDING TIME: 5 minutes

RELEASE OF INSECTS: in lavatory compartment only

TEST INSECT	NO. RELEASED	% RECOVERY	24 HR NET MORTALITY
Jumping Sumac Beetle Blepharida rhois 60 sec. dosage	80	84	97%
Colorado Potato Beetle Leptinotarsa 10-lineata 90 sec. dosage	100	86	26%
Colorado Potato Beetle Leptinotarsa 10-lineata 90 sec. dosage	50	78	18%
Colorado Potato Beetle Leptinotarsa 10-lineata 5 min. dosage	100	78	63%

FREE-FLIGHT DDT AEROSOL TEST
AIRCRAFT ON GROUND

AIRCRAFT: B-25

DISPENSER: Westinghouse DDT Lot No. 2

ENGINES OF AIRCRAFT: Not operating

DOSAGE: 3 1/2 min, released throughout entire aircraft

HOLDING TIME: 5 minutes

RELEASE OF INSECTS: in nose compartment only

TEST INSECT	NO. RELEASED	% RECOVERY	24 hr NET MORTALITY
Colorado Potato Beetle Leptinotarsa 10-lineata	100	75	76%

FREE-FLIGHT DDT AEROSOL TEST
AIRCRAFT ON GROUND

AIRCRAFT: C-47

DISPENSER: Westinghouse DDT Lot No. 2

ENGINES OF AIRCRAFT: Not operating

DOSAGE: 5 minutes

HOLDING TIME: 5 minutes

RELEASE OF INSECTS: Throughout aircraft except tail

TEST INSECT	NO. RELEASED	% RECOVERY	24 HR NET MORTALITY
Colorado Potato Beetle Leptinotarsa 10-lineata	300	100	82%
Weevil Eudiagogus sp.	150	31	18%
Jumping Sumac Beetle Blepharida rhois	300	72	99%
Stinkbug Mormidea pictiventris	80	40	51%

NOTE: The same number of each of the test insects was, as usual, released in an untreated C-47 as checks, and all visible specimens collected at the same time as the collections from the test plane. Twenty-four (24) hours later an opportunity was possible of inspecting beneath the floorboards of the check plane. At this time 17 Leptinotarsa were found here, all alive; one was in the act of dropping to the ground through a rivet hole. Six (6) more Leptinotarsa, eight (8) Eudiagogus and four (4) Blepharida were at the same time picked up alive on the ground beneath the plane.

FREE-FLIGHT DDT AEROSOL TEST
AIRCRAFT ON GROUND

AIRCRAFT: C-47

DISPENSER: Westinghouse DDT Lot No. 2

ENGINES OF AIRCRAFT: Not operating

DOSAGE: 10 minutes

HOLDING TIME: 5 minutes

RELEASE OF INSECTS: Throughout aircraft except tail

TEST INSECT	NO. RELEASED	% RECOVERY	24HR NET MORTALITY
Colorado Potato Beetle Leptinotarsa 10-lineata	350	81	59%
Weevil Eudiagogus sp.	120	28	63%
Jumping Sumac Beetle Blepharida rhois	300	74	100%
Stinkbug Mormidea pictiventris	125	63	100%
American Roach Periplaneta americana	25	28	57%

Inclosure 4

DDT AEROSOL RESIDUE DEPOSITION TESTS IN AIRCRAFT

Type of Aircraft: C-47
Test Insect: Housefly
Contact Period: 10 min.

PLANE SERIAL NO. AND DATE	TREATMENT		TESTS					
	SPRAYING	SETTLING PERIOD AFTER SPRAYING	MADE BEFORE SPRAYING		MADE AFTER SPRAYING		NET* GAIN OR LOSS** FROM PREVIOUS SPRAYING	
			* % KNOCKDOWN	24 HR KILL RATE* (%)	* % KNOCKDOWN	24 HR KILL RATE* (%)	* % KNOCKDOWN	24 HR KILL RATE* (%)
070								
1 Aug	60 sec.	5 min.						
2 Aug	60 sec.	5 min.						
3 Aug	60 sec.	5 min.						
4 Aug	60 sec.	5 min.						
5 Aug	60 sec.	5 min.						
6 Aug	60 sec.	5 min.						
7 Aug	60 sec.	5 min.						
8 Aug	60 sec.	5 min.						
9 Aug	60 sec.	5 min.						
10 Aug	60 sec.	5 min.						
11 Aug	60 sec.	5 min.						
12 Aug	60 sec.	5 min.						
13 Aug	60 sec.	5 min.						
14 Aug			0	6.8				
18 Aug	60 sec.	5 min.	0	23.8	2.9	36	2.9	16
20 Aug	60 sec.	5 min.	0	2.2	0	0	0	**2.6
22 Aug	60 sec.	5 min.	0	6.0	0	5.6	0	-0.4
25 Aug	60 sec.	5 min.	0	5.4	0	13.7	0	**8.8
25 Aug	60 sec.	5 min.	0	3.3	0	2.3	0	-1.3
27 Aug	60 sec.	30 min.	0	3.6	0	6.3	0	2.8
31 Aug	60 sec.	30 min.	0	9.9	0	12.1	0	2.4
31 Aug	60 sec.	30 min.	—	—	4.8	25.8	4.8	15.6
933								
14 Aug	60 sec.	5 min.	0	6.7	0	2.4	0	**-4.4
27 Aug	60 sec.	30 min.	0	0	0	2.7	0	2.7
28 Aug	60 sec.	30 min.	0	0	0	0.6	0	0.6
28 Aug	60 sec.	30 min.	0	2.7	0	8.9	0	6.4
841								
20 Aug	60 sec.	5 min.	0	0.8	0	0	0	**0.8
21 Aug	60 sec.	5 min.	0	4	0.8	5.4	0.8	4.6
22 Aug	60 sec.	5 min.	0.6	1.9	0	5.1	0.6	3.26
25 Aug	60 sec.	5 min.	0	0.6	0	0.1	0	**-0.55
1 Sep	60 sec.	30 min.	0	13.6	18	21	18	8.6
4 Sep***	60 sec.	30 min.	0	1.7	24	36.9	24	34.8
4 Sep****	60 sec.	30 min.	8.75	0	16.3	17.7	8.3	17.7
688								
22 Aug	60 sec.	5 min.	0	1.4	0.7	3.0	0.7	1.6

* "Net" percentages, calculated by Abbott's Formula.
** "Minus percentage", i.e., higher kill or knockdown before spraying than after.
*** Contact time of flies with treated surface increased to 60 minutes.
**** Contact time of flies with treated surface increased to 45 minutes.

ARMY AIR FORCES
AIR TECHNICAL SERVICE COMMAND
Engineering Division
Memorandum Report On TSEAM2/WRD/goa

Date: 10 January 1946

SUBJECT: Effect of DDT on the Materials of Aircraft Construction

OFFICE : MATERIALS LABORATORY Contract or Order No:

SERIAL NO: TSEAM-M5151, Add. II Expenditure Order No: 601-265

A. Purpose:

1. To determine the effect of DDT on the materials of aircraft and aircraft accessory construction.

2. Authority for this work is contained in E. O. 601-265.

B. FActual Data:

3. a. As a means of controlling the international transmission of insects and insect-borne disease an investigation of the use of DDT in disinsectization of aircraft and the aerial dispersal of insecticides was initiated at the Army Air Forces Center, Orlando, Florida. The Army Air Forces Board, Orlando, Florida, directed that this be done only if it could be done in such a manner as to cause no deleterious effects to either equipment or personnel. (Reference letter, The Army Air Forces Board, Orlando, Florida, Subject: AAF Board Project No. J-4671 - "Disinsectization of Aircraft Using DDT", to Director, ATSC, Wright Field, Dayton, Ohio, dated 26 May 1945). Insect control in airplanes was to be accomplished in 2 ways; (1) Aerosol control: DDT dusting powders and the aerosol bomb were suggested for this type of control; (2) Residual control: This was to be accomplished by using DDT dusting powders, DDT in solution or DDT smoke bomb. The AAF Board requested that the Materials Laboratory, ATSC, conduct the initial phase of the project which consisted essentially of the determination of the effect of all compounds submitted by them on the materials of aircraft construction. The AAF Center, Orlando, Florida, was to conduct the final portion of the project, which was the evaluation on aircraft of the insecticides.

b. The first item tested was the DDT smoke bomb. Type E-22, submitted by the Chemical Warfare Service, Edgewood Arsenal, Md., (Reference 3rd Indorsement to letter dated 18 June 1945 from AAF Tactical Center, Orlando, Florida, to: C.G. ASF, Attn: Chief CWS, Technical Division, subject: Procurement of DDT Smoke Grenades). The

results of the tests are reported in Memorandum Report TSEAM-M-5151 dated 15 August 1945. This report recommended that the DDT smoke bomb Type E-22 not be used in the disinsectization of aircraft because of the seriously corrosive effect on metals.

c. The AAF Center then submitted for test several solutions of DDT in organic solvents and several high strength organic solvents which were possible solvents for DDT. Results of tests are recorded in Memorandum Report TSEAM-M5151, Add. I, dated 6 September 1945. The report recommended that DDT dissolved in any of the solvents tested not be used in the disinsectization of aircraft or in the aerial dispersion of insecticides from aircraft because of the tendency of the solvents to swell the various rubbers used in aircraft construction. It was considered that any solvent strong enough to dissolve an effective amount of DDT (5% or more) would be likely to have a serious deleterious effect on rubbers. At this time the AAF Center reported that DDT dusting powders were not practical for residual control of insects in airplanes.

d. In letter 4 August 1945 from the Materials Laboratory, TSEAM2, to the AAF Center, Subject: Effect of DDT on the Materials of Aircraft Construction, it was recommended that DDT water dispersible powders be considered as a means of obtaining residual control of insects in airplanes. Several compounds were submitted by the AAF Center but none of the compounds tested met the AAF Center's requirements in dispersion stability and adherence after spraying. On the 6 October 1945, Colonel Benson of the AAF Center, during a visit to Wright Field, verbally requested the Materials Laboratory to assist in the development of a suitable DDT dispersible product for the residual control of insects in airplanes. The AAF Center had found that effective insect control could be achieved through the application on interior surfaces of a residual type insecticide supplemented by aerosol spray while in flight immediately after take-off.

4. A DDT dispersible compound to meet the requirements of the AAF Center must:

(1) Have no deleterious effects on the materials of aircraft construction.

(2) Produce a sufficiently stable suspension in water so that a minimum of sediment will form in 8 hours of settling and the sediment shall be readily redispersible.

(3) Have the ability to adhere sufficiently well to the surface (after spraying) to resist casual rubbing off and not powder off because of vibration.

(4) Retain adequate effectiveness as an insecticide even with a relatively large percentage of binder present (reference letter from the ATSC to the AAF Center, Subject: Dispersible DDT Powder, 20 November 1945).

The available formulations of all DDT dispersible compounds tested are tabulated in Table I, Appendix 3. Compound manufacturers and their symbol designations are listed in key sheet, Table II, Appendix 3.

5. At the invitation of the Materials Laboratory, Dr. Walker of the DuPont deNemours and Co., Experimental Station, Wilmington, Delaware, who was responsible for development of dispersible DDT compounds under NDRC contract, visited Wright Field 15 October 1945 to discuss current AAF requirements and the requisite further development work. Dr. Walker conducted several tests during his visit (outlined in Appendix I, Paragraph F) to ascertain if any compounds already developed could be modified to meet the requirements enumerated in Paragraph B-4.

6. Methods of tests conducted to determine the deleterious effects of dispersible DDT compounds on the materials of aircraft construction are outlined in Paragraphs A thru D, Appendix 1. Settling tests and adhesion tests were run on all dispersible compounds as outlined in Paragraph E, Appendix 1. In order to obtain proper dispersion of all components, the powders must first be mixed with water into a smooth paste. After this, the paste can be diluted to the desired concentration. Powders L, M and N were mixed one part by weight of powder to 1-3/4 parts by weight of water in the initial pastes, all other powders were mixed one part by weight of powder to one part by weight of water in the initial pastes.

7. It was thought that if DDT had a tendency to hydrolyze it might form acids. These acids would have a serious corrosive effect on the metals of aircraft construction which might not be apparent in the humidity cabinet. Two tests were run as described in Paragraph H1, Appendix 1. In these tests it was determined that the pH of DDT in water, even with aluminum ion present as a catalyst, was constant. A test as described in Paragraph H2, Appendix 1 was conducted. It was determined from this test that commercially pure DDT has no apparent corrosive effect on the metals of aircraft construction.

8. The DDT dispersible powders tested do not:

a. Have a corrosive effect on metals,
b. Lift or blister paints or finishes,
c. Cause rubber to swell,
d. Cause any visible effects on plastics.

These results are tabulated in Tables I - III, Appendix 2, DDT disper-

sible powder M produced a suspension sufficiently stable so that less than 10% by volume settled out in 3 hours and this was easily redispersed. It resisted casual rubbing (after spraying) and did not powder off because of vibration. A report from the AAF Center, Letter dated 11 December 1945, Subject: Tests on Dispersible DDT Formulation M, indicates that its initial insecticidal properties are sufficiently great to warrant its use and that its toxicity increases in respect to the toxicity of other DDT dispersible compounds as time progresses. This was the most satisfactory powder tested. Results of all tests are tabulated in Table IV, Appendix 2.

9. The DDT dusting powder tested did not:

a. Have a corrosive effect on metals,
b. Lift or blister paints or finishes,
c. Cause rubber swell,
d. Cause any visible effects on plastics.

Results of these tests are listed in Table VI, Appendix 2.

10. The aerosol bomb test contained 0.4% Pyrethins, 3% DDT, 5%, Cyclohexanone, 5% Lubricating oil and 86.6% Freon 12. This composition was tested as outlined in Paragraph G, Appendix 1 did not:

a. Have a corrosive effect on metals,
b. Lift or blister paints or finishes,
c. Cause rubber swell,
d. Cause any visible effects on plastics except that methyl methacrylate crazed when exposed to the direct spray from the bomb.

Results of tests are listed in Table V, Appendix 2.

C. Conclusions:

11. The DDT dispersible powders tested do not have a significant deleterious effect on the materials of aircraft construction. DDT dispersible powder M is the most satisfactory powder tested in regards to the AAF requirements as tabulated in Para. B4.

12. The DDT Aerosol bomb properly used does not have a significant deleterious effect on the materials of aircraft construction; however, the spray should not be applied directly on to surfaces and special care should be used near methyl methacrylate.

13. DDT dusting powders tested do not have a significant deleterious effect on the materials of aircraft construction.

14. Commercially pure DDT at a pH of 7-8 did not have a tendency to hydrolyze; nor did it appear to have any corrosive effect upon the metals tested.

D. Recommendations:

15. The Materials Laboratory (TSEAM), ATSC, recommends that when DDT is to be used as an insecticide where it will come in contact with airplanes, it be used in the following forms:

a. DDT dispersible powder similar to type M, suspended in water be used in the disinsectization of aircraft.

b. DDT dispersible powder similar to type M suspended in water, be used as the insecticide in the aerial dispersal of DDT insecticides when a liquid form is desired.

c. The aeirsol bomb be used in the disinsectization of aircraft where non-residual spray type treatment is desired.

d. DDT dissolved in organic solvent not be used either for disinsectization of aircraft or the aerial dispersal of insecticides because of the tendency to attack rubber.

/s/ Julius Teres
for

Distribution:
BAGR (4 cpys)
TSEXS- (3 cpys for forwarding to the AAF Center, Orlando, Florida).
TSEPE-9F-(1 cpy, Attn: Mr. Brown).
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DuPont Experimental Station,
Wilmington, Delaware
Attn: Dr. G. D. Patterson
TSEST

Prepared by: W. R. Day, Captain, A. C.

Approved by: LOUIS PERENY, Lt. Col., A.C.
Chief, Chemical Branch

Approved by: J. B. JOHNSON
Chief, Materials Laboratory
Aircraft and Physical
Requirements Subdivision
Engineering Division

Concurrence:

. . . . . .

. . . . . .

A. Test on Rubbers:

24 hour immersion tests were run on all rubber samples to determine percent swelling. Samples were weighed in air and in water, then immersed in the dispersion being tested for 24 hours, after which time they were wiped clean and dried and the weighings were repeated. The precent volume increase was calculated as follows:

$$\frac{(A - W) - (a - w)}{A - W} \times 100 = \% \text{ volume increase}$$

Where:

A = original weight of sample in air

W = original weight of sample in water

a = weight of sample in air after immersion in solvent

w = weight of sample in water after immersion in solvent

The amount of swell of rubber is indicative of the loss in physical properties of the rubber. The rubbers tested and results obtained are listed in Table I, Appendix 2.

B. Tests on Metals:

The metals were sprayed with the dispersion to be tested, placed in a humidity cabinet (Relative Humidity 95% Temperature 100 degrees F) and examined daily for incidence or extent of corrosion under 30 diameter magnification. The test was continued for 8 days. Results are listed in Table III, Appendix 2. In order to establish a basis for comparison, a similar set of metals which had not been exposed to DDT dispersions, was exposed to the humidity test and evaluated as before. Results are listed in Table III, Appendix 2.

C. Finishes:

The various finishes used were applied to 3" x 6" 245-T aluminum alloy panels. These panels were sprayed with the dispersion to be tested and evaluated daily for softening, lifting or blistering. The results are listed in Table II, Appendix 2. The finishes included in the test were: zinc chromate primer, Spec. AN-TT-P-656; darkened zinc chromate primer, Spec. AN-TT-P-656; black lacquer color No. 622 Spec.

AN-TT-L-51; sea gray enamel Color No. 603 Spec. AAF14109; varnish, Specs. AN-TT-V-116 and AN-TT-V-118.

D. Plastics:

The plastics with the exception of methyl methacrylate were cut into 6" x 3" panels and tested in the same manner as the finishes in paragraph C above. A crazing test was run on methyl methacrylate as outlined in AAF Spec. 14135 para. F15. The results of the test are listed in Table II, Appendix 2. The plastics included in the test were: methyl methacrylate (plexiglas) Spec. AN-P-44, clear cellulose acetate, Spec. 12025, and cotton fabric base phenolic, Spec. H-P-256.

E. Dispersion Stability and Adherence:

1. The dispersion stability was checked by making up a mixture of 10 grams of powder in 100 ml of water. This was placed in a 250 ml stoppered graduate, well dispersed by shaking and allowed to stand. Observations were made on the length of time it took the solids to settle, the number of ml of powder that did settle and the ease of redispersion. Results are listed in Table IV, Appendix 2.

2. Adherence was checked by spraying polished stainless steel panels with the above mixture. Panels were then allowed to dry for 2 hours and the adherence of the dried dispersion checked by rubbing the panel with the thumb using steadily increasing pressure. Results are listed in Table IV, Appendix 2.

F. Dr. Walker of the E.I. duPont DeNemours and Co., Experimental Station Wilmington, Delaware, conducted the following experiments at the Materials Laboratory:

1. The following 100 ml samples (10% mixtures by wt. of DDT dispersible powders in water) were placed in a 250 ml stoppered graduate, shaken well and allowed to stand for 3 hours. The following observations were made:

a. Powder "J". 5 ml of powder was caked on the bottom of the cylinder and was redispersed in 21 shakes.

b. "K". No powder was caked on the bottom but all the powder was in the lower 31 ml of the cylinder. It was redispersed in one shake.

c. "K" + 5% by weight of Methyl Cellulose (400 cps). All the powder was in the lower 46 ml of the cylinder and was redispersed in one shake.

d. "K" + 10% by weight of methyl cellulose (400 cps). All the powder was settled loosely in the lower 72 ml. of the cylinder and was redispersed in one shake.

e. "K" + 10% by weight of Polyvinyl Alchol - RH 623. All the powder was settled loosely in the lower 90 ml of the cylinder; 2-3 ml were caked on the bottom. It was redispersed in 3 shakes.

f. "H" + 0.59g Calcium Acetate Monohydrate. All the powder settled into the lower 50 ml of the cylinder and was redispersed in one shake.

g. "H" + 0.3g Calcium Acetate Monohydrate. All the powder settled into the lower 50 ml of the cylinder and was redispersed in one shake.

h. "H" + 0.15g Calcium Acetate Monohydrate. All the powder settled into the lower 50 ml of the cylinder and required one shake to redisperse.

Samples c., d. and e., exhibited poor adherence.

Samples a., and b., exhibited good adherence, (a) best.

G. The Aerosol Bomb:

Two tests were run on the Aerosol bomb.

1. Test specimens were placed in a stainless steel box approximately 16 cubic feet in volume and then the bomb was sprayed into the box for approximately 4 seconds. The bomb was then removed and the box sealed with heavy kraft paper and masking tape and allowed to stand 24 hours. The specimens were then removed from the box and tested as outlined in paragraphs A, B, C & D above. Results are listed in Table V, Appendix 2.

2. Another set of test specimens was exposed to the direct spray from the bomb. The specimens were allowed to stand for one hour and then tested as outlined in paragraphs A, B, C, & D above. Results are listed in Table V, Appendix 2.

H. DDT (Commercially Pure) Powder (Spec. JAN-D-56A):

The following two tests were run on commercially pure DDT furnished by AAF Center, Orlando, Florida:

1. Rate of Hydrolysis of DDT. A 5% by weight mixture of DDT powder (Spec. JAN-D-56A) in freshly boiled distilled water was made up and the pH determined at room temperature. This mixture was tested daily for 15 days. During this time the pH remained constant.

A 5% by weight mixture of DDT + 1% aluminum hydroxide in freshly boiled distilled water was made up and the pH determined daily (at room temperature) for 15 days. During this time the pH remained constant.

2. Corrosive effect of DDT on metals. A 10% by weight solution of DDT powder (Spec. JAN-D-56A) in acetone was prepared. This solution was sprayed on a set of metal panels. (Reference panels listed in Para. B., Appendix 1). The panels were allowed to dry for 15 minutes and were then tested as outlined in paragraph B above. Results of this test are listed in Table III, Appendix 2.

I. Corrosive Effect of DDT Dusting Powders on the Materials of Aircraft Construction:

The dusting powder (10% Micronized DDT in powdered talc) was placed on the material by dampening with distilled water. The panels were then dried in an oven 45 degrees C for 15 minutes. After this, the materials were tested as outlined in paragraphs A, B, C, and D, above.

TABLE I, Appendix 2

24-Hour Immersion % Swelling Test on Rubbers (Note 1)

DDT Dispersible Compound (Note 2)	GRN	GRS	GRM	Rubber Crude Rubber	Thiokol
A	Negligible	0.71%	Negligible	0.65%	Negligible
B	"	2.52	"	2.49	"
D	"	0.69	"	0.65	"
E	"	0.83	"	0.79	"
F	"	0.77	"	0.70	"
G	"	0.89	"	0.75	"
H	"	0.99	"	0.83	"
I	"	0.85	"	0.78	"
J	"	0.78	"	0.73	"
K	"	0.93	"	0.85	"
L	"	0.98	"	0.94	"
M	"	0.87	"	0.81	"
N	"	0.83	"	0.83	"

Note 1 : Maximum allowable swell varies from 0-35% depending upon the particular application in aircraft.

Note 2 : Aqueous dispersions containing 10% by weight of powder.

TABLE III, Appendix 2

Effect of Aqueous Dispersions of DDT Dispersible Compounds on Aircraft Metals

	24 ST Alum.	24 ST Alclad	Cadmium Plated Steel	Copper	Magnesium "C" Alloy Ascast Chrome Pickled	Cold Rolled Steel	Stainless 18-8 Steel
Compounds A-N Inclusive	Slight Pitting	None	Slight White Corrosion	Slight Corrosion Products	None	Rusted Seriously	None
Blank	"	"	"	"	"	"	"

Specimens were left in the humidity box for 8 days (95% RH 100 degrees F Temp)

Note 1: There was no noticeable difference between any of the dispersible compounds tested and the blank. In no case was the corrosive attack of DDT dispersions worse than if metals had been sprayed with water.

TSEAM-M5151, Add. II
E. O. No. 601-265
10 January 1946

TABLE II, Appendix 2

Effects of 10% Aqueous Dispersions of Various Dispersible Compounds on the Plastics and Finishes Listed

Plastic Dispersible / Spec.	Methyl Methacrylate AN-P-44	Cellulose Acetate 12025	Phenolic, Cotton Fabric Base H-P-265	Zinc Chromate Primer AN-TT-P-656	Darkened Zinc Chromate Primer AN-TT-P-656	Lacquer Color 662 AN-TT-L-51	Enamel Grey 603 14109	Varnish AN-TT-V-116	Varnish AN-TT-V-118
A	None	None	None	None	None	None	None	None	None
B	"	"	"	"	"	"	"	"	"
D	"	"	"	"	"	"	"	"	"
E	"	"	"	"	"	"	"	"	"
F	"	"	"	"	"	"	"	"	"
G	"	"	"	"	"	"	"	"	"
H	"	"	"	"	"	"	"	"	"
I	"	"	"	"	"	"	"	"	"
J	"	"	"	"	"	"	"	"	"
K	"	"	"	"	"	"	"	"	"
L	"	"	"	"	"	"	"	"	"
M	"	"	"	"	"	"	"	"	"
N	"	"	"	"	"	"	"	"	"

TABLE IV, Appendix 2

Suspension Stability and Adherence of Aqueous Dispersions of DDT Powders

Compound	Stability	Adherence to Panel
A	Fair	Poor
B	Fair	Fair
D	Poor	Fair
E	Fair	Poor
F	Fair	Fair
G	Fair	Fair
H	Fair	Fair
I	Fair	Fair
J	Fair	Fair
K	Good	Fair
L	Poor	Good
M	Excellent	Good
N	Fair	Good

Note 1: Stability rated in the following manner:

Poor - 50% of powder settled in 30 Minutes and hard to redisperse.

Fair - 50% of powder settled in 30 minutes and easy to redisperse, or 50% of powder settled in 3 hrs and hard to redisperse.

Good - 50% of powder settled in 3 hours and easy to redisperse or 50% of powder settled in 8 hours and hard to redisperse.

Excellent - Less than 10% of powder settled in 8 hours and easy to redisperse.

Note 2: Adhesion rated on the following bases:

Poor - Powder very loose on panel, no noticeable adhesion.

Fair - Powder resists very light rubbing.

Good - Powder resists fairly hard rubbing.

TABLE V, Appendix 2

Effect of Aerosol Bomb Composition on the Materials of Aircraft Construction

Materials	Exposed in Confined Space	Exposed to the Direct Spray from the Bomb
Alclad 24ST	No observable effect	No observable effects
Aluminum ST	"	"
Cadmium Plated Steel	"	"
Copper	"	"
Magnesium "C" Alloy Ascast	"	"
Chrome Pickle	"	"
Cold Rolled Steel	"	"
18-8 Stainless Steel	"	"
Methyl Methacrylate	"	Crazes
Cellulose Acetate	"	No observable effects
Phenolic, Fabric Base, Cotton	"	"
Zinc Chromate Primer	"	"
Darkened Zinc Chromate Primer	"	"
Lacquer Color #622, AN-TT-L-51	"	"
Enamel Grey, Color #603,14109	"	"
Varnish, AN-TT-V-116	"	"
Varnish, AN-TT-V-118	"	"
BUN	"	"
GRS	"	"
GRM	"	"
Crude Rubber	"	"
Thiokol	"	"

Note 1: Composition of the contents of the Aerosol Bomb:

0.4% Pyrethrins	5% Cyclo Hexanone	86.6% Freon 12
3% DDT	5% Lubricating Oil	

TABLE VI, Appendix 2

Effect of DDT Dusting Powder (10% DDT + 90% Talcum Powder) on the Materials of Aircraft Construction

Material	Results of Tests
Alclad 24ST	No observable effects
Aluminum 24ST	"
Cadmium Plated Steel	"
Copper	"
Magnesium "C" Alloy ascast Chrome pickle	"
Cold Rolled Steel	"
18-8 Stainless Steel	"
Methyl Methacrylate	"
Cellulose Acetate	"
Phenolic, Fabric Base Cotton	"
Zinc Chromate Primer	"
Darkened Zinc Chromate Primer	"
Lacquer Color #622, AN-TT-L-51	"
Varnish, AN-TT-V-116	"
Varnish, AN-TT-V-118	"
Enamel Grey, Color #603, 14109	"
Rubber, GRN	"
Rubber, GRS	"
Rubber, GRM	"
Crude Rubber	"
Thiokol F.S.	"

TABLE I, Appendix 3

Composition of DDT Dispersible Powders

Compound	Composition (From information available at this Headquarters)
B	54% DDT 46% Water
D	91% DDT (Aerosol Grade) 5% Santocel 58 2% Triton 770 2% Daxad 11
E	91½% DDT (Melting point 106° C.) 5% Santocel 58 2% Elvanol 51A-05 (polyvinyl alcohol) 1% Daxad 11 ½% Aresklene 400
K	90% DDT 7% Santocel 58 3% Igepon T
L	77% DDT 5% Santocel 58 16.7% Polyvinyl Alcohol RH623 0.4% Aresklene 400 0.9% Daxad 11
M	76.4% DDT 5.5% Super Absorbit 16.7% Polyvinyl Alcohol RH403 0.9% Daxad 11 0.4% Aresklene 400 0.1% Sodium Alginate
N	76.5% DDT 5.5% Super Absorbit 16.7% Polyvinyl Alcohol RH403 0.9% Daxad 11 0.4% Aresklene 400

TABLE II, Appendix 3

Compound	Manufacturers Code	Manufacturer
A	Deenol "F"	E.I. DuPont DeNemours & Co. Grasselli Chemicals Division
B	Suspension Concentrate	Chemical Warfare Service
C		Commercially Pure DDT
D	6002-60	E.I. DuPont DeNemours & Co. Experimental Station, Wilmington, Delaware.
E	6002-13913	E.I. DuPont DeNemours & Co. Experimental Station, Wilmington, Delaware.
F	6002-160	"
G	6002-161	"
H	6002-162	"
I	6002-163	"
J	6002-181	"
K	6327-1	"
L	6327-33A	"
M	6327-33B	"
N	6327-33C	"

ARMY AIR FORCES
Headquarters
Air Technical Service Command

In reply address both communication and envelope to attention of following office symbol:
TSEAL-4D

TSEAL-4D/WRD/hh
Wright Field, Dayton, Ohio

4 August 1945

SUBJECT: Effect of DDT on the Materials of Aircraft Construction.

TO : Commanding General
Army Air Forces Center
Orlando, Florida
Attention: Surgeon

1. A preliminary report is submitted as requested by letter 14 June 1945, subject: Effect of DDT sprays and dusts on aircraft parts, fixtures, equipment and paint, Army Air Forces Center, Orlando, Florida.

2. Per cent swell tests were run on several types of rubber. The rubber was immersed in the fluid for 24 hours and the volume increase determined. The results are tabulated below:

% Increase in Volume of Rubber Samples.

Type Rubber	Trade Name	5% DDT Kerosene	5% DDT Fuel Oil #2	1% DDT 2-1/2% Thenite Kerosene	5% DDT Deo Base	K327
GRN	Buna N	0.341	2.8	1.70	00.845	226.0
GRS	Buna S	118.5	142.9	137.3	94.9	281.9
GRM	Neo-prene	13.47			6.0	

3. A per cent swell of 35% is the maximum swell considered safe for non-stressed rubber parts. In stressed parts any swell is undesirable. This is particularly true of bungee rings and instrument panel mounts. In the case of instrument panel mounts swelling changes the rate of vibration which would affect the accuracy of some instruments. It can be seen from the table that the most seriously affected rubber is GRS. It is the experience of this headquarters that natural rubber closely approximates GRS in solvent resistance and will therefore be serioualy affected by these solvents. Some of the parts on aircraft where GRS and/or natural rubber are used are instrument panel mounts,

dynafocal mounts, bungee shock mounts and rings, tires, weather stripping, wire insulation, life rafts, Mae Wests and miscellaneous molded parts. Using the above information as a basis, this headquarters recommends that DDT carried in any solvents so far tested not be used to spray aircraft. It is expected that the other solvents suggested will be as bad or worse than deobase. The high solvency materials such as ortho-dichlorobenzene and xylene can be expected to be much worse.

4. It is the opinion of this Headquarters that the most likely possibilities for obtaining residual control without deleterious effects to the aircraft are water suspensions, water emulsions, dusting and a modified freon bomb. Emulsions must be of the oil in water type, that is droplets of DDT solvent surrounded by water. A test to distinguish this type of emulsion is as follows: Dissolve a small amount of a water soluble dye in water. Add some of this to the emulsion to be tested and shake well. If the dye gives a uniform color to the mixture, the emulsion is of the oil in water type. If the dye is insoluble and remains in small droplets, the emulsion is of the water in oil type.

5. The freon bomb would have to be modified to contain a high concentration of DDT so that enough DDT would be deposited to give a residual effect. Information on the practicability of designing such a bomb would be appreciated. Work is being conducted to determine the possible deleterious effects of emulsions, suspensions, dusting, and the freon bomb on the material of aircraft construction.

FOR THE COMMANDING GENERAL:

/s/ J. B. JOHNSON
/t/ J. B. JOHNSON
Chief, Materials Laboratory
Aircraft and Physical
Requirements Subdivision
Engineering Division

ARMY AIR FORCES
Headquarters
Air Technical Service Command TSEAL-4D/WRD/hh

In reply address
both communication
and envelope to attention
of following office symbol:
TSEAL-4D

Wright Field, Dayton, Ohio

18 July 1945

SUBJECT: Effect of DDT Smoke Grenades
on Aircraft Materials

TO: Commanding General
Army Air Forces Center
Orlando, Florida
Attention: Surgeon

1. Two tests were run using a DDT smoke grenade. A complete report will be submitted as soon as final results from the tests are available.

2. The first test was run in a small airtight chamber and the bomb was in the chamber for approximately 45 seconds. The second test was run in a gas chamber of approximately 2500 cubic feet in volume. It was observed that there was some leakage from this chamber. The materials were placed six feet from the bomb. In test one a glass-plate was included in the sample and it was computed that 2400 milligrams of DDT were deposited per square foot. In test two, three glass plates were placed 2 feet, 5 feet and 9 feet from the grenade and the concentration of DDT was 39.6 milligrams/ square foot, 34.8 milligrams/ sq. foot and 36.0 milligrams/sq. foot respectively.

3. The effects of the test on aircraft materials were:

a. Rubbers, paints, and plastics - no short time deleterious effects.

b. Metals - accelerated corrosion especially serious on iron, magnesium, copper, aluminum (24ST) and alclad. Cadmium plated iron and stainless steel showed evidence of accelerated corrosion but to a less serious extent. The results were the same for test one and two but were not as serious in test two.

4. Conclusions drawn from these tests:

a. Extreme caution should be used in disinsectization of

aircraft with a DDT smoke grenade as this grenade has a serious deleterious effect on the metals used in aircraft construction.

5. Air Shipment of DDT materials has been received.

FOR THE COMMANDING GENERAL:

/s/ J. B. Johnson
/t/ J. B. JOHNSON
Chief, Materials Laboratory
Aircraft and Physical
Requirements Subdivision
Engineering Division

ARMY SERVICE FORCES
Office Chief of Chemical Warfare Service
Washington 25, D C

In reply
refer to: SPCVD

23 July 1945

SUBJECT: Candle, Insecticide, E22

TO : Surgeon
Air Forces Center
Orlando, Florida
ATTENTION: Capt. Alexander B. Klots, Sn C

One copy of Report of Trip to Wright Field, Ohio, Subject: "Preliminary Tests on DDT Grenades by the Air Technical Service Command, Wright Field, Ohio," dated 21 July 1945, by Charles E. Waters, Captain, Chemical Warfare Service, is inclosed for your information.

FOR THE CHIEF, CHEMICAL WARFARE SERVICE:

/s/ Millard F. Peake
Lt. Col., C.W.S.
for W. C. KABRICH
Brig. Gen., USA
Chief, Tech Div

1 Incl
Report of Trip
dtd 21 July 45

ARMY SERVICE FORCES
OFFICE CHIEF OF CHEMICAL WARFARE SERVICE
Edgewood Arsenal, Maryland

SPCVL 680.2

CEW/hml/6255
21 July 1945

TITLE: Report of Trip to Wright Field, Ohio, 9 July to 14 July 1945

SUBJECT: Preliminary Tests on DDT Grenades by the Air Technical Service Command, Wright Field, Ohio.

1. Introduction: The purpose of this trip was to deliver ten (10) E22 DDT grenades to the Air Technical Service Command, for use in tests to determine the effect of the smoke emitted by the grenades upon the materials of which airplanes are made. The Technical Division representative discussed the behavior of the grenades, and the methods for testing them, with personnel who will actually perform the tests, and assisted in two preliminary experiments.

2. Conclusions:

a. No conclusion as to whether the grenades can or cannot be used in airplane cabins without significant damage to the plane has yet been reached.

b. The smoke deposit is definitely corrosive to bare, cold rolled steel, and appears to be somewhat corrosive to certain other metals. The seriousness of this corrosion has not been established.

c. Gross contamination with the smoke deposit has some effect upon certain paints and rubber compounds. It has not been determined whether this effect is serious.

d. Possible effects of the smoke upon the functioning of instruments or other equipment have not been investigated.

e. The persistent odor emitted by the grenades may be a serious objection to their use inside of airplanes.

3. Recommendations: None

4. Action Taken: None

5. Details:

a. In compliance with paragraph 19, Special Order 190, Headquarters, C.W. Center, Edgewood Arsenal, Md., dated 9 July 1945, the undersigned left Edgewood Arsenal on 9 July 1945, and arrived at

[illegible] Field, Ohio, on 10 July 1945. He left Wright Field on 13 July 1945, and arrived at Edgewood Arsenal on 14 July 1945. Upon arrival at Wright Field, he reported to Lt. Colonel R. C. Kinne, C.W.S.Liaison Officer. He was introduced by Major J. L. Banks, of Colonel Kinne's office, to Lt. Colonel L. Pereny, under whose direction most of the tests are to be carried out. Colonel Pereny is Chief of the Chemical Branch, Materials Laboratory, Engineering Division, Air Technical Service Command. This branch is designated by the symbol TSEAL-4D.

b. Ten (10) grenades were carried to Wright Field. Six of them marked "E22", were from a lot of fifty (50), the remainder of which was sent to the Army Air Forces Center at Orlando, Florida. The other four, unmarked, were made especially for these tests. All grenades contained, as the main filling, 340-350 grams of the following composition:

sodium chlorate (micropulverized)	12%
sucrose (micropulverized)	36%
DDT (commercial)	52%

The six (6) grenades marked "E22" contained no starter except about eight (8) grams of the same mixture, loose in the core space. In the other four (4) grenades the top surface of the filling and the inner surface of the core space were coated with a slurry of sulfurless meal powder and the core space was otherwise empty. The M18 can was used in all ten grenades, and all had bouchon type igniters.

c. Although the filling of these grenades had approximately the same percentage of DDT as the fillings in the grenades taken to Savannah and to Beltsville, it differed considerably in that it contained a much greater percentage of sucrose, and no Celite. This new filling gives less decomposition of the DDT (judging by analysis of solid collected from the smoke cloud), and burns more slowly. It is also denser.

d. It was learned from conversation with Colonel Pereny that the tests on grenades are merely a part of a larger program, in which the effect of numerous compositions containing DDT upon materials of aircraft construction is to be determined. Work on the program had not started because a shipment of DDT and solvents to be sent from the Army Air Forces Center had not been received.

e. The following are among the possible harmful effects which must be considered:

General Effects:
- Creation of a fire hazard;
- Deposition of sticky material on seats, manual controls, or other objects;
- Creation of persistent odors;

Damage to Materials:
Corrosion of metals, which may cause malfunctioning or even structural failure;
Softening or surface etching of plastics, such as Plexiglas domes;
Softening and swelling of rubber compounds, such as insulation on wires, and seals at doors and windows;
Softening of putty-like materials used for sealing;
Softening of paint or other finishes;

Interference with Instruments:
Clogging of bearings;
Changing of calibration, by partial plugging of orifices;
Clogging of air filters.

Effects in the last group would probably be investigated by the Equipment Laboratory, rather than by the Materials Laboratory.

f. So far as DDT compositions are concerned, the principal interest is in residual treatments, applied at a dosage of 200 to 400 milligrams per square foot. It is not certain how often treatments would be repeated or whether a considerable build-up of deposit would be permitted to occur. It has not been indicated whether cargo placed in a treated plane would likewise be treated.

g. It was explained to Colonel Pereny that the grenades could not be expected to deposit 200 to 400 milligrams per square foot except upon floors or other upward-facing surfaces, and that the deposit upon vertical or downward-facing surfaces would be very light, though toxic. It was felt, nevertheless, that deposits of the desired density should be made on the test specimens, since they might be obtained in some locations, particularly after repeated treatment.

h. Two preliminary tests were made while the undersigned officer was present. In one test the deposit was very heavy, about 2.5 grams per square foot, while in the other it was rather light, about 35 milligrams per square foot. Observation of the test specimens is continuing. These tests were run by 1st Lt. W. R. Day, who is in the Electrochemical Unit, the chief of which is Captain J. Teres. Samples of paints, plastics and sealing compounds were prepared and examined by Mr. N. T. Lendzian, of the Paint Unit. The samples of rubber compounds were to be examined and tested by Mr. L. M. Peterson, Chief of the Textile and Rubber Branch of the Materials Laboratory. Assistance was given by Sgt. F. M. Hickey, from Colonel Kinne's office.

i. In the first test, the samples were placed on the bottom of a stainless steel box 42" long, 24" wide, and 30" deep. A cover

of heavy Kraft paper, to be sealed with masking tape, was provided. At the start of the test this was sealed over half (one end) of the box, and the other part was folded back. One grenade, marked E22, was ignited in a bucket, outside of the box. As soon as it was well started, the bucket was lowered into the box. When it appeared that smoke evolution was nearly complete, the remainder of the cover was sealed in place, with the bucket and grenade still in the box. This grenade flamed slightly at the start, but the flame extinguished itself within a few seconds. The burning time could not be determined exactly, but was about 3-1/2 minutes, more than twice as long as that of the grenades used at Savannah and Beltsville. This test was started at about 1445 on 1[illegible] July 1945. The next morning the cover was removed and the samples were taken from the box. All had a brown, oily coating, which had started to crystallize in a few places. Although only a small portion of the total smoke was finally sealed in the box, the heaviness of the deposit makes it evident that deposition was occurring during the entire period of burning.

j. The following are the samples used in the first test, and the preliminary observations on them:

(1) A glass disc, 4" in diameter, was used to give the dosage. This picked up 0.2169 grams, equivalent to 2.48 grams per square foot.

(2) A glass dish, about 6-1/2" x 11-1/2" x 4" filled to a depth of about 1/2" with freshly boiled, distilled water. At the end of the test, there was much sediment and the 80 ml. of water was colored yellow. The pH was 2.3. The total acidity and inorganic chloride contents of the water had not been determined when the Technical Division representatives left.

(3) Metals: These were panels, 2" x 4", of various thicknesses. The surfaces were cleaned with solvents, but were not buffed or given any other special treatment. After removal from the box, the panels were placed in a cabinet at 100°F. and 95% relative humidity. They were examined one and three days (total time) after being placed in the cabinet. For examination, the deposit on a small part of the surface was removed by rubbing with a cloth dipped in acetone, and the exposed surface was examined by means of a microscope under oblique illumination.

Cold Rolled Steel: Since the surface was heavily rusted after one day, the panel was not replaced in the cabinet.

Stainless Steel: No definite sign of corrosion.

Cadmium Plated Steel: No apparent corrosion

Copper: Somewhat darkened; surface slightly etched; very slight green coating, in small patches.

Aluminum Alloy (24ST): Some pitting seen after one day; apparently increased after three days.

Alclad (pure aluminum on aluminum alloy): There appeared to be a few deep pits.

Magnesium (cast Dowmetal C in heat treated condition): After one day gray spots appeared on surface; after three days there appeared to be slight pitting.

(4) Plastics: These were pieces (about 6" x 3") of the sheet materials, clear cellulose acetate. Plexiglas (methyl methacrylate), and structural Bakelite (a fabric base, phenolic resin laminated material). The smoke deposit appeared to have no effect upon them.

(5) Rubber Compounds: The samples were squares (approximately 6" x 6") of black sheet material about 1/8" thick. The five samples contained respectively, natural rubber, Buna S, neoprene, and two types of Thiokol. All but the neoprene showed some swelling of the exposed surface. This was not considered to be necessarily very serious. These samples were exposed again in the second test, and were then turned over to the Textile and Rubber Branch for test. No results have yet been obtained.

(6) Finishes: There were five finishes on aluminum panels about 6" x 2-1/2". The finishes were: Zinc chromate primer, two coats of darkened primer, zinc chromate primer plus A.A.F. specification paint number 14109, paint number 14109 alone, and lacquer (type not specified). There was also a 16" square fabric panel (on a wooden frame), coated with celluse nitrate dope. The deposit appeared to penetrate into the primer, softening it so that it was removed when rubbed with a cloth soaked in alcohol. No other effect was apparent, three days after removal of the samples from the box.

k. The second test was made in a gas chamber, ordinarily used for training troops. The chamber is a structure of corrugated iron, of the Quonset hut type, 21'8" long, 16' wide at the bottom, and 9'2" high at the middle. The volume and floor are approximately 2580 cubic feet and 347 square feet, respectively. The samples were placed on the floor, all about six feet from the center, except that the three glass discs were placed 2', 5'8" and 8'8" from the center. One of the unmarked grenades was burned in a bucket, placed at the center of the floor. There was no flaming. The evolution of smoke was observed through an open door for about 1-1/2 minutes, until smoke

[illegible] to escape through the door. After the door was closed smoke could be seen escaping through numerous cracks in the chamber. The test was started at 1005 on 12 July 1945. When the chamber was reentered at 1430, no smoke was left, though the characteristic odor of the grenades was quite apparent. The samples, which had received a light deposit, were removed for examination.

1. The following are the samples used in the second test, and the preliminary observations on them:

(1) The glass discs (4" diameter) received deposits of 3.3 mg., 2.9 mg., and 3.0 mg., corresponding to 38 mg., 33mg., and 34 mg., per square foot, respectively.

(2) The water in the glass dish (the same dish as was used in the preceding test) had little or no sediment, and was still colorless. It was placed in a bottle, to be tested later.

(3) Metals: These were similar to those used in the first test. After removal from the gas chamber they were put into the cabinet at 100°F. and 95% relative humidity, and were examined 18 hours later.

Cold Rolled Steel: The face was definitely rusted while the back had only a few small rust spots.

Cadmium Plated Steel; No apparent corrosion.

Copper: No apparent corrosion.

Aluminum Alloy: Slight indication of pitting.

Alclad: Some pits were seen, but may have been present before exposure.

Magnesium: No apparent corrosion.

(4) Plastics: These were pieces of sheet materials, clear cellulose acetate, 1/4" thick (much thicker than was used in the first test), Plexiglas, and structural Bakelite. The last two were from the sheets from which the samples used in the first test were cut. None of these materials was visibly affected.

(5) Rubber Compounds: The samples used in the first test were exposed again, with the same side uppermost. New samples of the same materials were exposed also. There was no visible effect upon any of these samples. All were turned over to the Textile and Rubber Branch for testing.

(6) Sealing Compounds: The materials were Aircraft Instrument Sealing Compound, a tacky, putty-like material; Pressurized Cabin Sealing Compound, a non-tacky, fibrous material; and Seam Sealing Compound, a tacky material which is used for sealing pressurized cabins. Layers of the first two materials were exposed on metal panels. The last of the three was tested as an adhesive between two metal panels, only a little of the material being directly exposed. None of these materials was visibly affected.

(7) Finishes: There were four finishes on aluminum panels. These were: zinc chromate primer, darkened zinc chromate primer, gray camouflage enamel. and cellulose nitrate gloss lacquer. There was also a 16" square fabric panel, painted with 554 cellulose nitrate dope (part orange-yellow, and part aircraft gray). Part of the panel was covered with a black plastic strip coating, a type of material which is used to protect equipment in transit, and is then stripped off, leaving a clean surface. None of these materials was visibly affected.

m. Further Work:

(1) Observations on the samples exposed in these two tests will be continued.

(2) It is expected that one or more additional tests will be made in an attempt to get a deposit of 200 to 400 milligrams per square foot. It was urged that this could be done best in a tight chamber comparable in size to the gas chamber. However, since there seems to be no such chamber available, the test will probably be made like the first one, except that the grenade will be kept in the box for only a fraction of the total period of emission.

(3) It is not known what tests will be made to determine the effect of the smoke upon instruments. It was considered that at this stage it was unnecessary and even undesirable to contact personnel of the Equipment Laboratory, which will probably conduct the tests.

(4) The question of conducting a test in an airplane was discussed, but it is not known whether such a test will be run. The decision no doubt depends partly on the results of the preliminary tests.

n. The following points came up in discussions with Colonel Pereny, and others:

(1) These tests could be made more easily if the grenades were smaller. It was agreed that smaller grenades could be made, but it was pointed out that the ones submitted were the same as those sent to the Army Air Forces Center at Orlando, Florida, and that it was not certain whether a change in size would or would not

change the composition of the smoke.

(2) If persistent, the odor emitted by the grenades would be objectionable in an enclosed space. It may be mentioned that personnel of the Carter Memorial Laboratory at Savannah, Georgia, also noticed the odor, and found it to last for at least two weeks indoors, even though the room was aired out from time to time.

(3) The slowness of the deposit in crystallizing is objectionable, especially when it is heavy. An oily coating on seats or controls would be heartily disliked by crew members and passengers. Moreover, it is probable that the coating can cause more damage to materials while still liquid than after it has crystallized.

(4) Although the deposit obtained in the first test, nearly 2.5 grams per square foot, seems excessive, it is possible that this concentration might be built up in certain parts of a plane upon repeated treatment.

(5) The results obtained up to now are only preliminary. No statement as to whether the grenades can be used safely in planes can yet be made.

o. The undersigned officer took advantage of an opportunity to witness a test of visual signalling devices which might be used by grounded airmen to attract the attention of rescuers. The test was run by the Land Rescue and Sea Rescue Units of the Personal Equipment Laboratory of the Air Technical Service Command. It took place on 10 July 1945, partly in the late afternoon, and partly at night. Since this is a matter of some interest to the C.W.S., it is believed that the C.W.S. Liaison Officer will obtain the conclusions when they become available. The test showed clearly that the duration of a signal is just as important as its brilliance.

/s/ CHARLES E. WATERS
Captain, C.W.S.
Coordination & Test Branch

HEADQUARTERS
ARMY AIR FORCES TACTICAL CENTER
Orlando, Florida

LAB/ABC/ea-7

29 May 1945

Please address reply to:
COMMANDING GENERAL
AAF TACTICAL CENTER
ORLANDO, FLORIDA
ATTN: Surgeon's Office

SUBJECT: Internal Volume and Internal Surface Area Data.

TO: Director, Air Technical Service Comd.
Wright Field, Dayton, Ohio
Attention: TSESE-416 (Capt. C. C. Braswell).

1. The following data are desired in connection with AAF Board Project No. J-4671, "Disinsectization of Aircraft using DDT":

a. The total volume of air inside the fuselage of various aircraft listed below. This figure need not include the volumes of apparatus and equipment normally present in such aircraft, or of personnel or cargo which might be in the aircraft.

b. The total internal surface area of the fuselage of each type of aircraft. Preferably, this should include the areas of all surfaces of fabric linings, bulk heads, partitions, struts, braces, seats, and other similar major integral parts and fittings of the aircraft, but need not include surfaces of instruments and apparatus.

2. If possible, data are requested for the following types of aircraft:

P-38	C-46	B-17
P-47	C-47	B-24
	C-54	B-25
		B-29

3. In order to avoid needless complications in the preparation of these figures, it is suggested that minor considerations such as the volumes and areas of items as rivet heads and small projections be ignored. A deviation of 10% plus or minus is sufficiently accurate for the purpose for which the figures are required.

4. This is a first priority project. Classification is SECRET.

FOR THE COMMANDING OFFICER:

/s/ L. A. Bilotta
/t/ L. A. BILOTTA
Lt. Colonel, Medical Corps,
Acting Surgeon, AFTAC.

Incl. 9

Subject: Internal Volume and Internal Surface Area Data.

1st Ind TSESE-416

Hq, AAF Board ATSC, Wright Field - Dayton, Ohio 30 June 1945

To: Commanding General, AAF Tactical Center, Orlando, Florida,
Attn: Surgeon's Office

1. In accordance with request made in basic communication the following data is submitted herewith.

Airplane	Volume (Cu.Ft.)	Area (Sq.Ft.)
P-38	65	322
P-47	285	570
C-46	3,600	3602
C-47	2,400	3375
C-54	4,860	4100
B-17	2,520	2750
B-24	2,700	3000
B-25	1,000	1600
B-29	5,000	4500

C. C. Braswell, Capt., A.C.
for H. Y. SMITH
Colonel, Air Corps
Chief, Engineering Standards
Section
Service Engineering Subdivision
Engineering Division

Incl. 9

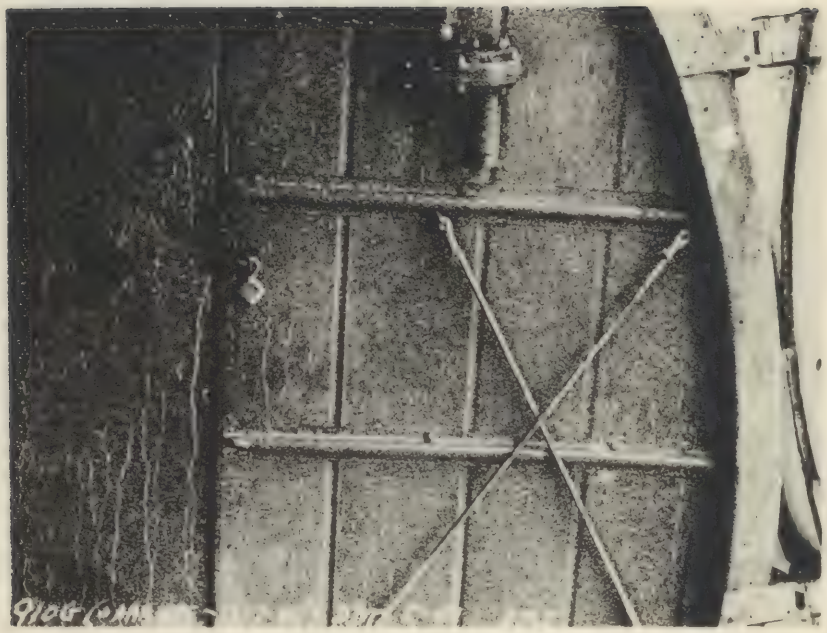

Fig. 1. Appearance of DDT Residue. A portion of painted duralumin bulkhead in a C-47 showing the noticeable, dried DDT residue from an aqueous suspension spray.

Fig. 2. Wiping Spray Residue. The dried-on spray can easily be wiped off with a dry cloth. A valuable DDT residue remains even after thorough wiping.

Fig. 3. Applying Residue Spray in Nose of C-47. The "Lofstrand" sprayer is shown in use, with a short spray tube. It is essential that out-of-the-way portions of aircraft like this be treated very thoroughly.

Fig. 4. Residue Spraying Beneath Flooring of Radio-Navigation Compartment, C-47. The flooring having been removed, a thorough residue-treatment is applied to all surfaces beneath. The space beneath this flooring is very frequently and easily entered by insect "stowaways".

Fig. 5. Applying Residue Spray Behind Fabric Insulation Lining, C-47. The spaces behind fabric linings are very important, being accessible to insects through many apertures. The lining must be mostly or entirely removed for treatment.

Fig. 6. Spraying in Cargo Compartment, C-47. The central strip of flooring must be removed for treatment of spaces beneath. Note the application, shown here, of spray to back and under surfaces of the bucket seats.

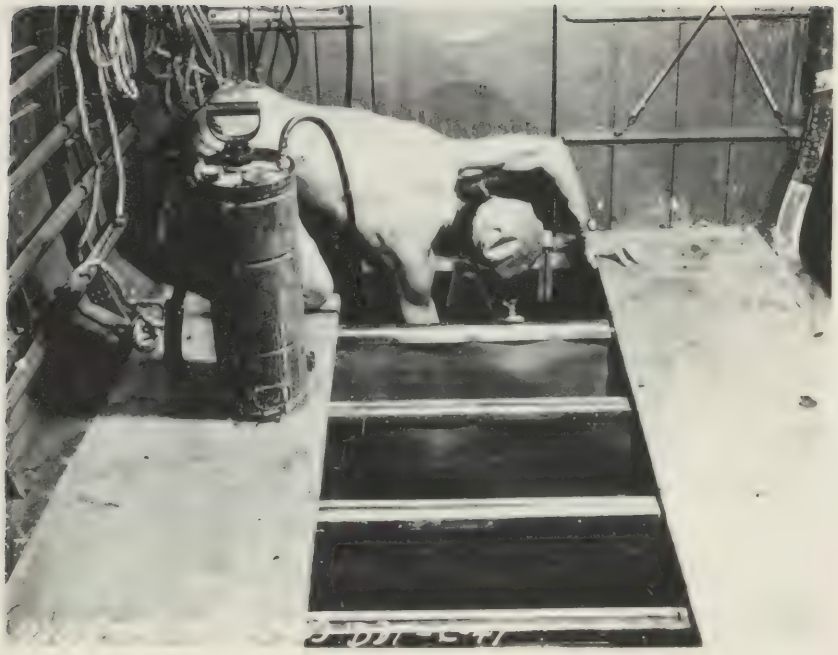

Fig. 7. Spraying Beneath Lavatory Floor from Rear of Cargo Compartment, C-47. The center strip of flooring should be removed all the way to the rear of the cargo compartment. In work like this a short angled spray tube is almost essential.

Fig. 8. Spraying Tail from Lavatory, C-47. For this the longer spray tube and cone spray nozzle, giving a longer range, are advisable. The tail can thus be sprayed from front and rear ends without entering it (See Fig. 9).

Fig. 9. Spraying Interior of Tail from Rear. Compare with Fig. 8.

Fig. 10. Adaptations of Lofstrand Sprayer Equipment for Spraying Aircraft. Shown here are accessory shut-off valve just in front of standard pistol-grip release valve; short, angled spray tube for use beneath flooring and in confined quarters; and standard nozzle.

Fig. 11. Use of Short, Angled Spray-Tube for Spraying Beneath Flooring of B-17. This modification of the standard Lofstrand sprayer spray-tube is essential for spraying beneath the fixed flooring of many types of aircraft. Treatment beneath such flooring is absolutely essential.

Fig. 12. Use of Lofstrand Sprayer in B-17 Aircraft. A residual spray is being applied to the sides of the waist compartment, using the Cone Spray nozzle.

Fig. 13. Use of "Sure-Shot" High Pressure Sprayer. This small capacity sprayer was found extremely valuable for spraying in cramped quarters, and around instruments which it is necessary not to wet. It sprays in a narrow cone and gives an excellent, wet residual spray.

Fig. 14. Use of Sprayer, Insecticide, Continuous Spray, 3-qt. This, the standard QM issue hand sprayer, can be used as a substitute for other, better sprayers.

Fig. 1. Loading Residual Test Cages. The residual test cages are here shown being loaded from a laboratory culture of standard houseflies.

Fig. 2. Residual Toxicity Laboratory Test. A series of residual test cages of standard houseflies is here shown on treated samples of various materials of aircraft construction. Note data Sheets, which are filled in as 100% knockdown occurs in various cages; and stack of three "control" cages for detection of accidental contamination or other invalidating factors.

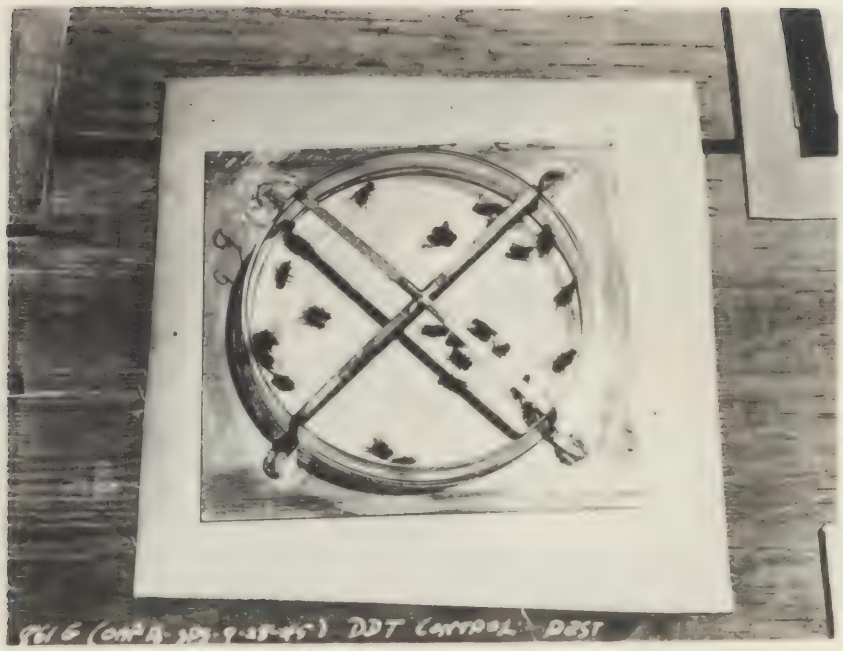

Fig. 3. Residual Test Cage of Houseflies in Position on Sample. The flies are watched constantly during the test. The time from first exposure to 100% knockdown is recorded. If 100% knockdown is not obtained with 2 hours exposure the cage is removed, the flies transferred to a clean holding cage, and mortality after 24 hours recorded.

Fig. 4. Complete Knockdown of Test Flies in Residual Test Cage. The standard residual test cages are made of glass Petri dishes held to a metal frame. They insuré contact of the test insects with the surface being treated for toxicity.

LIST OF DISPERSIBLE DDT FORMULATIONS USED IN TESTS

ATSC SYMBOL	DU PONT CODE NO.	FORMULATION
—	6001-21	90% DDT (Hercules Aerosol grade or equiv.) 6.75% Santocel 58 (Monsanto's silica aerogel) 3.25% Aresklene 400 (Monsanto's dibutyl phenyl phenol sodium disulfonate)
D	6002-60	91% DDT (Herc, Aerosol gr.) 5% Santocel 58 2% Triton 770 (Rohm & Haas' sodium aryl alkyl polyether sulfate 2% Daxad 11 (Dewey & Ahney's naphthalene sodium sulfonate - formaldehyde condensation product
—	6002-62	90% DDT (Herc. Aerosol gr.) 0.5% Aresklene 400 1% Daxad 11 2% Polyvinyl alcohol (DuPont's "Elvanol" 50A-42) 6.5% Super Absorbit (Alexite Engineering Co.'s. expanded vermiculite
—	6002-64	94% DDT (Herc. Aerosol gr.) 3% Santocel 58 1% Daxad 11 2% Nacconol NRSF (sodium alkyl aryl sulfonate, National Aniline Division, Allied Chemical & Dye)
E	6002-71 or 6002-13913	91.5% DDT (Herc, Aerosol gr.) 5% Santocel 58 0.5% Aresklene 400 1% Daxad 11 2% Polyvinyl alcohol (DuPont's "Elvanol" 51A-05)
F	6002-160	90% DDT (melting point 106° C.) 5.5% Super Absorbit 2% Daxad 11 2% Elvanol 50A-42 0.5% Aresklene 400

ATSC SYMBOL	DU PONT CODE NO.	FORMULATION
G	6002-161	90% DDT (m.p. 106° C.) 6% Santocel 58 3% Aresklene 400 1% Daxad 11
H	6002-162	90% DDT (m.p. 106° C.) 6% Santocel 58 3% Santomerse No. 3 (dodecyl benzene sodium sulfonate) 1% Daxad 11
I	6002-163	90.5% DDT (m.p. 106° C.) 6% Santocel 58 2% "Elvanol 51A-05" 1% Daxad 11 0.5% Aresklene 400
—	6002-163B	90.5% DDT (purified grade) 6% Santocel 58 2% PVA RH623 1% Daxad 11 0.5% Aresklene 400
—	6002-168B	90% DDT (Aerosol grade) 7% Santocel 58 3% Igepon T
K	6327-1	90% DDT (purified grade) 7% Santocel 58 3% Igepon T ($C_{17}H_{33}CON\ (CH_3)\ C_2H_4SO_3Na$)
M	6327-33B	76.4% DDT (purified grade) 5.5% Super Absorbit 16.7% PVA RH403 0.9% Daxad 11 0.4% Aresklene 400 0.1% Sodium Alginate

TESTS OF DISPERSIBLE DDT AQUEOUS SUSPENSION RESIDUES
ON VARIOUS AIRCRAFT MATERIALS

TESTS OF DURABILITY ON VARIOUS MATERIALS

SERIES A - One sample of each material was treated with each DDT formulation, and these were tested for toxicity unwiped. Simultaneously another set of identically prepared samples was tested after being wiped thoroughly with dry cloths.

Materials	Average, Minutes to 100% Knockdown	
	Set of Unwiped Samples	Set of Samples Wiped Once
Duralumin, painted	22.0	47.9
Duralumin, unpainted	17.7	45.4
Plexiglas	16.9	67.0
Wing fabric, painted	18.8	34.2
AVERAGE OF ABOVE	18.8	48.6
B-29 fabric lining	56.5	**
B-32 fabric lining	54.0	**
AVERAGE OF "B" LININGS	55.3	**
AVERAGE, ALL MATERIALS	46.5	**

SERIES B - Further tests on the same samples. The set which had not been wiped previously was wiped. The set which had been wiped was wiped again.

Materials	Average, Minutes to 100% Knockdown	
	Set of Samples Wiped Once	Set of Samples Wiped Twice
Duralumin, painted	54.2	120.0
Duralumin, unpainted	64.9	120.0
Plexiglas	114.4	160.9
Wing Fabric, painted	44.1	79.1
AVERAGE OF ABOVE	69.4	120.0
B-29 fabric lining	64.4	**
B-32 fabric lining	25.3	**
AVERAGE, "B" LININGS	59.9	**
AVERAGE, ALL MATERIALS	66.6	**

** Lack of test material allowed preparation of only one set of B-29 and B-32 linings.

TESTS OF THE COMPARATIVE DURABILITY OF VARIOUS FORMULATIONS

SERIES C - The same tests as in SERIES A listed to show the comparative toxicity of the various dispersible DDT formulations tested.

Formulation DuPont Code	Averages, Minutes to 100% Knockdown			
	Tests on Duralumin, Painted Duralumin, Plexiglas and Painted Wing Fabric		Tests on B-29 fabric Lining	Tests on B-32 fabric Lining
	Unwiped Samples	Samples Wiped Once	Unwiped Samples	Unwiped Samples
6002-20	15.1	50.7	44.0	35.8
6002-62	21.8	53.7	54.1	47.0
6002-64	20.8	33.8	53.1	57.1
Deenol 50F	17.5	56.2	75.0	76.0
AVERAGES	18.8	48.6	56.5	54.0

SERIES D - The same tests as in SERIES B showing the comparative toxicity of the various dispersible DDT formulations, after wiping the samples. Those not previously wiped were wiped. Those previously wiped were wiped again.

Formulation DuPont Code	Averages, Minutes to 100% Knockdown			
	Tests on Duralumin, Painted Duralumin, Plexiglas and Painted Wing Fabric		Tests on B-29 fabric Lining	Tests on B-32 fabric Lining
	Samples Wiped once	Samples Wiped twice	Samples Wiped once	Samples Wiped once
6002-20	71.7	162.4	56.1	51.3
6002-62	67.6	114.9	95.9	54.0
6002-64	59.0	94.3	57.4	59.3
Deenol 50F	79.3	108.5	48.0	56.4
AVERAGES	69.4	120.0	64.4	55.3

COMPARISON TESTS, DISPERSIBLE DDT FORMULATIONS
6002-62 AND 6327-33B (ATSC Type M)

Tests with Standard Houseflies, on 6" Square Plates of OD Painted Duralumin with Standard Residual Test Cages

TABLE I

TEST NO.	NO. OF FLIES IN TEST	TEMPER-ATURE, ° F.	MIN TO 100% KD @ RESIDUE CONCENTRATIONS AND FORMULATIONS LISTED			
			5 mg per sq ft		10 mg per sq ft	
			6002-62	6327-33B	6002-62	6327-33B
1	164	78°	20.0	37.5	17.0	28.0
2	167	75°	16.5	29.0	16.0	22.0
3	143	75°	24.0	22.0	22.0	28.0
4	158	78°	25.0	28.5	23.5	21.5
5	166	85°	26.5	23.5	23.5	26.0
6	162	77°	30.5	33.5	41.5	47.5
7	111	79°	14.5	22.5	27.0	22.5
8	107	78°	35.5	30.0	33.0	34.5
9	155	72°	24.0	51.0	32.5	44.5
10	137	62°	63.0	50.5	53.0	40.0
11	159	70°	62.5	65.0	70.0	49.5
12	150	78°	65.0	90.0	39.0	72.5
13	155	68°	61.5	50.0	53.5	42.0
14	161	90°	63.0	65.0	47.1	33.0
15	156	90°	58.1	39.1	47.0	36.0
16	276	85°	76.0	75.1	89.1	78.0
17	237	80°	76.1	72.1	90.0	77.1
18	295	80°	97.1	74.1	143.1	85.1
19	160	80°	75.0	75.0	90.0	87.0
20	320	85°	174.0	245.0	294.1	164.0
Totals	3539					
Averages			43.2	41.4	56.1	51.9

COMPARISON TESTS, DISPERSIBLE DDT FORMULATIONS
6002-62 AND 6327-33B (ATSC Type M)

Tests with Standard Houseflies, on 6" Square Plates of OD Painted Duralumin with Standard Residual Test Cages

TABLE II

TEST NO.	NO. OF FLIES IN TEST	TEMPERATURE ° F.	MIN TO 100% KD & RESIDUE CONCENTRATIONS AND FORMULATIONS LISTED			
			50 mg per sq ft		100 mg per sq ft	
			6002-62	6327-33B	6002-62	6327-33B
1	155	73°	16.5	35.0	22.5	42.0
2	157	75°	20.0	32.0	22.5	41.5
3	159	80°	14.0	28.5	19.0	14.5
4	161	72°	17.5	33.0	16.5	23.5
5	155	75°	20.0	30.5	15.5	23.5
6	107	80°	13.0	17.0	12.5	15.5
7	174	80°	19.5	19.5	14.5	17.5
8	122	70°	21.5	19.0	21.5	15.0
9	148	78°	20.5	33.0	20.0	24.5
10	153	80°	26.5	27.5	27.5	24.5
11	154	70°	20.5	18.5	19.5	17.0
12	149	80°	29.5	33.5	34.0	28.0
13	157	80°	30.0	30.0	32.0	25.5
14	146	69°	19.0	17.0	17.0	17.0
15	157	75°	30.5	33.0	34.0	27.0
16	152	72°	17.0	18.5	17.0	17.5
17	154	75°	34.0	29.5	28.5	27.6
18	158	85°	34.5	34.0	28.0	27.5
19	155	85°	32.0	30.0	30.0	32.5
20	166	78°	18.0	16.5	14.0	12.0
21	157	75°	17.5	15.5	16.0	15.0
22	164	75°	20.0	17.5	17.5	20.5
23	163	85°	22.0	38.0	20.0	24.5
24	162	85°	24.5	38.5	23.0	26.0
25	160	80°	30.0	30.0	19.0	27.5
26	147	77°	34.0	31.0	26.5	32.0
27	99	79°	24.5	33.5	19.5	27.0
28	121	78°	20.5	25.0	26.0	24.0
29	150	80°	15.0	19.5	18.5	22.5
30	154	68°	14.0	18.5	12.0	22.0
31	156	72°	23.5	30.5	16.5	39.0
32	168	90°	33.0	35.0	45.0	32.1
33	166	90°	34.1	40.0	45.1	34.0
34	176	86°	31.0	28.1	27.0	38.0
35	167	85°	35.0	43.1	26.0	47.1
36	189	85°	27.0	32.0	23.1	32.1
37	194	85°	27.1	22.1	16.1	34.1
38	189	80°	29.1	26.0	21.0	25.1
39	293	80°	27.0	31.1	24.0	33.0
40	306	80°	37.1	47.0	22.1	26.1
41	309	84°	36.0	50.1	36.1	41.1
Totals Averages	6829		24.8	28.9	23.1	26.7

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: C-47.
Serial No. : 070.
Date Treated : 2 October 1945.

Treatment : 200 mg sq. ft.
Formulation: DuPont Deenol 50 F.
Test Insect: Housefly.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OR MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
	Wiped	1	18	48.0	4	73	0/73 = 0.0	33/73 = 45.2	51/91	56.0
12 Oct	Not Wiped	5	82	23.0	-	--	---	---	82/82	100.0
	BOTH	6	100	27.2	4	73	0/73 = 0.0	33/73 = 45.2	133/173	76.8
	Wiped	3	50	55.0	2	30	3/30 = 10.0	26/30 = 86.6	79/80	98.8
18 Oct	Not Wiped	5	79	17.6	-	--	---	---	79/79	100.0
	BOTH	8	129	31.6	2	30	3/30 = 10.0	26/30 = 86.6	158/159	99.3
	Wiped	3	49	53.3	2	30	0/30 = 0.0	8/79 = 10.1	57/79	72.2
19 Oct	Not Wiped	5	80	17.0	-	--	---	---	80/80	100.0
	BOTH	8	129	30.6	2	30	0/30 = 0.0	8/79 = 10.1	137/159	86.1
	Wiped	3	51	38.3	2	31	0/31 = 0.0	28/31 = 90.3	79/82	95.4
30 Oct	Not Wiped	4	68	20.2	-	--	---	---	68/68	100.0
	BOTH	7	119	30.9	2	31	0/31 = 0.0	28/31 = 90.3	147/150	98.0
	Wiped	1	17	92.0	4	85	3/85 = 3.5	70/85 = 82.3	92/102	90.2
31 Oct	Not Wiped	4	93	25.0	-	--	---	---	93/93	100.0
	BOTH	5	110	38.4	4	85	3/85 = 3.5	70/85 = 82.3	185/195	94.8
	Wiped	3	46	60.0	2	29	0/29 = 0.0	3/29 = 10.4	49/75	65.3
1 Nov	Not Wiped	4	53	38.3	-	--	---	---	53/53	100.0
	BOTH	7	99	47.6	2	29	0/29 = 0.0	3/29 = 10.4	102/128	79.6
	Wiped	1	13	43.0	4	53	0/53 = 0.0	46/83 = 86.7	59/66	89.3
2 Nov	Not Wiped	3	43	21.6	-	--	---	---	43/43	100.0
	BOTH	4	56	27.0	4	53	0/53 = 0.0	46/83 = 86.7	102/109	93.6
	Wiped	5	72	43.4	-	--	---	---	72/72	100.0
9 Nov	Not Wiped	4	50	23.2	-	--	---	---	50/50	100.0
	BOTH	9	122	37.2	-	--	---	---	122/122	100.0
	Wiped	4	53	48.7	1	11	2/11 = 18.2	2/11 = 18.2	55/64	86.0
27 Nov	Not Wiped	5	73	28.4	-	--	---	---	73/73	100.0
	BOTH	9	126	37.4	1	11	2/11 = 18.2	2/11 = 18.2	128/137	93.3
	Wiped	3	30	89.3	2	24	0/24 = 0.0	13/24 = 54.1	43/54	79.6
4 Dec	Not Wiped	5	56	17.0	0	--	---	---	56/56	100.0
	BOTH	8	86	44.1	2	24	0/24 = 0.0	13/24 = 54.1	99/110	90.0
	Wiped	27	399	55.8	23	366	8/366 = 2.2	229/366 = 64.3	628/765	82.1
Summary	Not Wiped	44	677	22.9	0	--	---	---	677/677	100.0
	BOTH	71	1076	36.8	23	366	8/366 = 2.2	229/366 = 64.3	1305/1442	90.5

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: C-47. Treatment : 200 mg sq. ft.
Serial No. : 070. Formulation: DuPont Deenol 50 F.
Date Treated : 2 October 1945. Test Insect: Anopheles quadrimaculatus.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF ANOPHELES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF ANOPHELES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF ANOPHELES	PERCENT
19 Oct	Wiped	5	88	15.0	0	--	--	--	88/88	100.0
	Not Wiped	5	87	14.0	0	--	--	--	87/87	100.0
	BOTH	10	175	14.5	0	--	--	--	175/175	100.0
30 Oct	Wiped	5	92	38.6	0	--	--	--	92/92	100.0
	Not Wiped	4	86	25.0	0	--	--	--	86/86	100.0
	BOTH	9	178	32.5	0	--	--	--	178/178	100.0
31 Oct	Wiped	5	117	47.8	0	--	--	--	117/117	100.0
	Not Wiped	4	86	33.2	0	--	--	--	86/86	100.0
	BOTH	9	203	41.3	0	--	--	--	203/203	100.0
Summary	Wiped	15	277	33.8	0	--	--	--	277/277	100.0
	Not Wiped	13	259	23.3	0	--	--	--	259/259	100.0
	BOTH	28	536	28.9	0	--	--	--	536/536	100.0

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: C-47.
Serial No. : 664.
Date Treated : 4 October 1945.

Treatment : 200 mg sq. ft.
Formulation: DuPont Deenol 50 F.
Test Insect: Housefly.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
	Wiped	3	48	78.6	2	29	0/29 = 0.0	23/29 = 79.3	71/77	92.3
22 Oct	Not Wiped	5	80	16.2	0	—	—	—	80/80	100.0
	BOTH	8	128	39.5	2	29	0/29 = 0.0	23/29 = 79.3	151/157	96.1
	Wiped	3	51	28.3	2	29	1/29 = 3.4	25/29 = 86.2	76/80	95.0
22 Oct	Not Wiped	5	84	22.2	0	—	—	—	84/84	100.0
	BOTH	8	135	24.5	2	29	1/29 = 3.4	25/29 = 86.2	160/164	97.5
	Wiped	5	64	51.4	0	—	—	—	64/64	100.0
23 Oct	Not Wiped	5	69	19.4	0	—	—	—	69/69	100.0
	BOTH	10	133	35.4	0	—	—	—	133/133	100.0
	Wiped	3	48	29.6	2	30	0/30 = 0.0	18/30 = 60.0	66/78	84.6
23 Oct	Not Wiped	5	83	17.0	0	—	—	—	83/83	100.0
	BOTH	8	131	21.8	2	30	0/30 = 0.0	18/30 = 60.0	149/161	92.4
	Wiped	5	80	60.0	0	—	—	—	80/80	100.0
24 Oct	Not Wiped	5	92	24.8	0	—	—	—	92/92	100.0
	BOTH	10	172	42.4	0	—	—	—	172/172	100.0
	Wiped	4	69	51.5	1	16	4/16 = 25.0	14/16 = 87.5	83/85	97.6
25 Oct	Not Wiped	5	65	25.7	0	—	—	—	65/65	100.0
	BOTH	9	134	38.6	1	16	4/16 = 25.0	14/16 = 87.5	148/150	98.5
	Wiped	3	42	72.3	2	36	0/36 = 0.0	27/36 = 75.0	69/78	88.5
29 Oct	Not Wiped	5	95	18.0	0	—	—	—	95/95	100.0
	BOTH	8	137	38.3	2	36	0/36 = 0.0	27/36 = 75.0	164/173	94.6
	Wiped	3	49	62.6	2	31	0/31 = 0.0	31/31 = 100.0	80/80	100.0
29 Oct	Not Wiped	4	63	17.2	0	—	—	—	63/63	100.0
	BOTH	7	112	36.7	2	31	0/31 = 0.0	31/31 = 100.0	143/143	100.0
	Wiped	5	68	35.6	0	—	—	—	68/68	100.0
13 Nov	Not Wiped	4	43	18.2	0	—	—	—	43/43	100.0
	BOTH	9	111	31.4	0	—	—	—	111/111	100.0
	Wiped	3	42	50.3	1	11	0/11 = 0.0	11/11 = 100.0	53/53	100.0
29 Nov	Not Wiped	5	73	18.4	0	—	—	—	73/73	100.0
	BOTH	8	115	30.4	1	11	0/11 = 0.0	11/11 = 100.0	126/126	100.0
	Wiped	4	41	63.5	1	14	0/14 = 0.0	13/14 = 92.9	54/55	98.3
10 Dec	Not Wiped	5	58	22.0	0	—	—	—	58/58	100.0
	BOTH	9	99	40.4	1	14	0/14 = 0.0	13/14 = 92.9	112/113	99.0
	Wiped	41	602	51.9	13	196	5/196 = 2.5	162/196 = 82.7	764/798	95.8
Summary	Not Wiped	53	805	20.0	0	—	—	—	805/805	100.0
	BOTH	94	1407	32.9	13	196	5/196 = 2.5	162/196 = 82.7	1569/1603	97.7

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: C-47. Treatment : 200 mg sq. ft.
Serial No. : 664. Formulation: DuPont Beenol 50 F.
Date Treated : 4 October 1945. Test Insect: Anopheles quadrimaculatus.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF ANOPHELES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF ANOPHELES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF ANOPHELES	PERCENT
22 Oct	Wiped	5	93	38.0	0	—	—	—	93/93	100.0
	Not Wiped	5	98	25.0	0	—	—	—	98/98	100.0
	BOTH	10	191	31.5	0	—	—	—	191/191	100.0
23 Oct	Wiped	5	102	30.4	0	—	—	—	102/102	100.0
	Not Wiped	5	98	14.8	0	—	—	—	98/98	100.0
	BOTH	10	200	22.6	0	—	—	—	200/200	100.0
23 Oct	Wiped	5	101	21.4	0	—	—	—	101/101	100.0
	Not Wiped	5	92	15.6	0	—	—	—	92/92	100.0
	BOTH	10	193	18.5	0	—	—	—	193/193	100.0
24 Oct	Wiped	5	100	38.4	0	—	—	—	100/100	100.0
	Not Wiped	5	119	18.6	0	—	—	—	119/119	100.0
	BOTH	10	219	28.5	0	—	—	—	219/219	100.0
25 Oct	Wiped	5	94	55.4	0	—	—	—	94/94	100.0
	Not Wiped	4	109	30.0	0	—	—	—	109/109	100.0
	BOTH	9	203	44.1	0	—	—	—	203/203	100.0
Summary	Wiped	25	494	36.7	0	—	—	—	494/494	100.0
	Not Wiped	24	516	20.5	0	—	—	—	516/516	100.0
	BOTH	49	1010	28.7	0	—	—	—	1010/1010	100.0

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-25.
Serial No. : 910.
Date Treated : 6 October 1945.

Treatment : 200 mg sq. ft.
Formulation: DuPont Deenol 50 F.
Test Insect: Housefly.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
16 Oct	Wiped	6	82	70.3	0	--	---	---	82/82	100.0
	Not Wiped	6	76	30.8	0	--	---	---	76/76	100.0
	BOTH	12	158	50.6	0	--	---	---	158/158	100.0
22 Oct	Wiped	6	97	26.8	0	--	---	---	97/97	100.0
	Not Wiped	6	92	27.0	0	--	---	---	92/92	100.0
	BOTH	12	189	26.9	0	--	---	---	189/189	100.0
22 Oct	Wiped	5	72	57.4	1	17	0/17 = 0.0	14/17 = 82.3	86/89	96.5
	Not Wiped	6	106	17.1	0	--	---	---	106/106	100.0
	BOTH	11	178	35.4	1	17	0/17 = 0.0	14/17 = 82.3	192/195	98.4
23 Oct	Wiped	4	75	58.5	2	33	6/33 = 18.2	32/33 = 97.0	107/108	99.0
	Not Wiped	6	110	29.5	0	--	---	---	110/110	100.0
	BOTH	10	185	41.1	2	33	6/33 = 18.2	32/33 = 97.0	217/218	99.5
23 Oct	Wiped	4	77	43.7	1	16	0/16 = 0.0	16/16 = 100.0	93/93	100.0
	Not Wiped	4	66	25.7	0	--	---	---	66/66	100.0
	BOTH	8	143	34.7	1	16	0/16 = 0.0	16/16 = 100.0	159/159	100.0
24 Oct	Wiped	4	71	57.7	2	40	0/40 = 0.0	21/40 = 52.5	92/111	83.0
	Not Wiped	3	49	29.0	0	--	---	---	49/49	100.0
	BOTH	7	120	45.4	2	40	0/40 = 0.0	21/40 = 52.5	141/160	88.2
5 Dec	Wiped	6	69	41.5	0	--	---	---	69/69	100.0
	Not Wiped	6	63	17.2	0	--	---	---	63/63	100.0
	BOTH	12	132	29.4	0	--	---	---	132/132	100.0
7 Dec	Wiped	6	77	41.6	0	--	---	---	77/77	100.0
	Not Wiped	6	64	35.0	0	--	---	---	64/64	100.0
	BOTH	12	141	38.3	0	--	---	---	141/141	100.0
Summary	Wiped	41	620	48.9	6	106	6/106 = 5.7	83/106 = 78.4	703/726	96.8
	Not Wiped	43	626	26.2	0	---	---	---	626/626	100.0
	BOTH	84	1246	37.3	6	106	6/106 = 5.7	83/106 = 78.4	1329/1352	98.2

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-25.
Serial No. : 910.
Date Treated : 5 October 1945.

Treatment : 200 mg sq. ft.
Formulation: DuPont Deenol 50 F.
Test Insect: Anopheles quadrimaculatus.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF ANOPHELES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF ANOPHELES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF ANOPHELES	PERCENT
	Wiped	7	111	54.1	0	--	---	---	111/111	100.0
22 Oct	Not Wiped	6	114	19.0	0	--	---	---	114/114	100.0
	BOTH	13	225	37.9	0	--	---	---	225/225	100.0
	Wiped	6	145	57.5	0	--	---	---	145/145	100.0
23 Oct	Not Wiped	6	142	29.6	0	--	---	---	142/142	100.0
	BOTH	12	287	43.6	0	--	---	---	287/287	100.0
	Wiped	5	80	33.6	0	--	---	---	80/80	100.0
23 Oct	Not Wiped	4	78	19.0	0	--	---	---	78/78	100.0
	BOTH	9	158	27.1	0	--	---	---	158/158	100.0
	Wiped	6	132	60.8	0	--	---	---	132/132	100.0
24 Oct	Not Wiped	3	74	27.0	0	--	---	---	74/74	100.0
	BOTH	9	206	49.4	0	--	---	---	206/206	100.0
	Wiped	24	468	52.3	0	--	---	---	468/468	100.0
Summary	Not Wiped	19	408	23.6	0	--	---	---	408/408	100.0
	BOTH	43	876	39.6	0	--	---	---	876/876	100.0

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-25.
Serial No. : 913.
Date Treated : 11 October 1945.

Treatment : 200 mg sq. ft.
Formulation: 6002-160.
Test Insect: Housefly.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
15 Oct	Wiped	5	60	47.4	1	14	5/14 = 35.8	14/14 = 100.0	74/74	100.0
	Not Wiped	6	88	27.0	0	—	---	---	88/88	100.0
	BOTH	11	148	36.2	1	14	5/14 = 35.8	14/14 = 100.0	162/162	100.0
16 Oct	Wiped	6	76	74.1	0	—	---	---	76/76	100.0
	Not Wiped	6	90	25.8	0	—	---	---	90/90	100.0
	BOTH	12	166	49.9	0	—	---	---	166/166	100.0
18 Oct	Wiped	6	74	65.0	0	—	---	---	74/74	100.0
	Not Wiped	6	69	28.3	0	—	---	---	69/69	100.0
	BOTH	12	143	46.6	0	—	---	---	143/143	100.0
19 Oct	Wiped	6	93	55.0	0	—	---	---	93/93	100.0
	Not Wiped	6	70	30.0	0	—	---	---	70/70	100.0
	BOTH	12	163	42.5	0	—	---	---	163/163	100.0
30 Oct	Wiped	6	102	72.5	0	—	---	---	102/102	100.0
	Not Wiped	6	89	23.1	0	—	---	---	89/89	100.0
	BOTH	12	191	47.8	0	—	---	---	191/191	100.0
30 Oct	Wiped	5	84	33.2	1	15	0/15 = 0.0	6/15 = 40.0	90/99	91.0
	Not Wiped	6	103	27.3	0	—	---	---	103/103	100.0
	BOTH	11	187	30.0	1	15	0/15 = 0.0	6/15 = 40.0	193/202	95.5
5 Nov	Wiped	2	24	109.0	3	47	4/47 = 8.5	31/47 = 66.0	55/71	77.5
	Not Wiped	1	12	35.0	0	—	---	---	12/12	100.0
	BOTH	3	36	84.3	3	47	4/47 = 8.5	31/47 = 66.0	67/83	80.7
6 Nov	Wiped	3	54	34.3	2	29	0/29 = 0.0	7/29 = 24.1	61/83	73.4
	Not Wiped	3	48	22.3	0	—	---	---	48/48	100.0
	BOTH	6	102	28.3	2	29	0/29 = 0.0	7/29 = 24.1	109/131	83.1
7 Nov	Wiped	6	81	31.1	0	—	---	---	81/81	100.0
	Not Wiped	6	90	27.6	0	—	---	---	90/90	100.0
	BOTH	12	171	29.4	0	—	---	---	171/171	100.0
9 Nov	Wiped	6	89	43.8	0	—	---	---	89/89	100.0
	Not Wiped	6	88	30.7	0	—	---	---	88/88	100.0
	BOTH	12	177	35.8	0	—	---	---	177/177	100.0
27 Nov	Wiped	5	77	65.8	1	12	0/12 = 0.0	12/12 = 100.0	89/89	100.0
	Not Wiped	6	74	24.1	0	—	---	---	74/74	100.0
	BOTH	11	151	43.1	1	12	0/12 = 0.0	12/12 = 100.0	163/163	100.0
11 Dec	Wiped	5	51	57.2	1	10	0/10 = 0.0	7/10 = 70.0	58/61	95.0
	Not Wiped	6	69	26.0	0	—	---	---	69/69	100.0
	BOTH	11	120	40.2	1	10	0/10 = 0.0	7/10 = 70.0	127/130	97.7
Summary	Wiped	61	865	55.1	9	127	9/127 = 7.1	77/127 = 60.6	942/992	95.0
	Not Wiped	64	890	27.2	0	---	---	---	890/890	100.0
	BOTH	125	1755	40.8	9	127	9/127 = 7.1	77/127 = 60.6	1832/1882	97.4

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-25. Treatment : 200 mg sq. ft.
Serial No. : 913. Formulation: 6002-160.
Date Treated : 11 October 1945. Test Insect: Anopheles quadrimaculatus

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF ANOPHELES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF ANOPHELES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF ANOPHELES	PERCENT
30 Oct	Wiped	6	117	38.3	0	—	—	—	117/117	100.0
	Not Wiped	6	119	29.0	0	—	—	—	119/119	100.0
	BOTH	12	236	33.7	0	—	—	—	236/236	100.0
30 Oct	Wiped	6	147	78.3	0	—	—	—	147/147	100.0
	Not Wiped	6	145	26.6	0	—	—	—	145/145	100.0
	BOTH	12	292	52.5	0	—	—	—	292/292	100.0
Summary	Wiped	12	264	56.3	0	—	—	—	264/264	100.0
	Not Wiped	12	264	27.8	0	—	—	—	264/264	100.0
	BOTH	24	528	42.6	0	—	—	—	528/528	100.0

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-17. Treatment : 100 mg sq. ft.
Serial No. : 042. Formulation: 6002-160.
Date Treated : 2 November 1945. Test Insect: Housefly.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
	Wiped	5	76	39.4	0	--	---	---	76/76	100.0
6 Nov	Not Wiped	5	78	30.6	0	--	---	---	78/78	100.0
	BOTH	10	154	35.0	0	--	---	---	154/154	100.0
	Wiped	5	97	42.0	0	--	---	---	97/97	100.0
7 Nov	Not Wiped	5	72	34.0	0	--	---	---	72/72	100.0
	BOTH	10	169	38.0	0	--	---	---	169/169	100.0
	Wiped	5	79	36.6	0	--	---	---	79/79	100.0
8 Nov	Not Wiped	5	76	24.4	0	--	---	---	76/76	100.0
	BOTH	10	155	30.5	0	--	---	---	155/155	100.0
	Wiped	4	62	34.7	1	15	0/15 = 0.0	14/15 = 93.3	76/77	98.6
9 Nov	Not Wiped	5	77	28.8	0	--	---	---	77/77	100.0
	BOTH	9	139	31.4	1	15	0/15 = 0.0	14/15 = 93.3	153/154	99.3
	Wiped	5	96	53.0	0	--	---	---	96/96	100.0
13 Nov	Not Wiped	5	85	27.4	0	--	---	---	85/85	100.0
	BOTH	10	181	40.2	0	--	---	---	181/181	100.0
	Wiped	5	103	57.6	0	--	---	---	103/103	100.0
13 Nov	Not Wiped	5	82	31.0	0	--	---	---	82/82	100.0
	BOTH	10	185	44.3	0	--	---	---	185/185	100.0
	Wiped	5	72	34.8	1	8	4/8 = 50.0	6/8 = 75.0	78/80	97.5
26 Nov	Not Wiped	6	76	17.3	0	--	---	---	76/76	100.0
	BOTH	11	148	25.2	1	8	4/8 = 50.0	6/8 = 75.0	154/156	98.7
	Wiped	6	59	37.0	0	--	---	---	59/59	100.0
7 Dec	Not Wiped	6	66	32.0	0	--	---	---	66/66	100.0
	BOTH	12	125	34.5	0	--	---	---	125/125	100.0
	Wiped	40	644	39.4	2	23	4/23 = 17.4	20/23 = 87.0	664/667	99.4
Summary	Not Wiped	42	612	28.0	0	--	---	---	612/612	100.0
	BOTH	82	1256	33.5	2	23	4/23 = 17.4	20/23 = 87.0	1276/1279	99.7

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-17.
Serial No. : 738.
Date Treated : 17 October 1945.

Treatment : 200 mg sq. ft.
Formulation: 6002-150.
Test Insect: Housefly.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
	Wiped	5	75	37.0	0	--	---	---	75/75	100.0
31 Oct	Not Wiped	5	72	26.0	0	--	---	---	72/72	100.0
	BOTH	10	147	31.5	0	--	---	---	147/147	100.0
	Wiped	5	90	33.6	0	--	---	---	90/90	100.0
1 Nov	Not Wiped	5	88	29.2	0	--	---	---	88/88	100.0
	BOTH	10	178	31.4	0	--	---	---	178/178	100.0
	Wiped	5	101	25.5	0	--	---	---	101/101	100.0
1 Nov	Not Wiped	6	78	17.8	0	--	---	---	78/78	100.0
	BOTH	12	179	21.7	0	--	---	---	179/179	100.0
	Wiped	6	93	24.7	0	--	---	---	93/93	100.0
2 Nov	Not Wiped	6	89	25.3	0	--	---	---	89/89	100.0
	BOTH	12	182	25.0	0	--	---	---	182/182	100.0
	Wiped	6	60	29.0	0	--	---	---	60/60	100.0
5 Nov	Not Wiped	6	69	36.6	0	--	---	---	69/69	100.0
	BOTH	12	129	32.8	0	--	---	---	129/129	100.0
	Wiped	6	99	22.6	0	--	---	---	99/99	100.0
7 Nov	Not Wiped	6	91	27.0	0	--	---	---	91/91	100.0
	BOTH	12	190	24.8	0	--	---	---	190/190	100.0
	Wiped	6	101	23.6	0	--	---	---	101/101	100.0
8 Nov	Not Wiped	6	96	22.8	0	--	---	---	95/96	100.0
	BOTH	12	197	23.2	0	--	---	---	197/197	100.0
	Wiped	6	95	49.1	0	--	---	---	95/95	100.0
9 Nov	Not Wiped	6	104	33.0	0	--	---	---	104/104	100.0
	BOTH	12	199	41.0	0	--	---	---	199/199	100.0
	Wiped	46	714	30.5	0	--	---	---	714/714	100.0
Summary	Not Wiped	46	687	27.2	0	--	---	---	687/687	100.0
	BOTH	72	1401	28.9	0	--	---	---	1401/1401	100.0

CONSOLIDATION, RESIDUAL TOXICITY CAGE TEST IN TREATED AIRCRAFT

Aircraft, Type: B-17. Treatment : 200 mg sq. ft.
Serial No. : 738. Formulation: 6002-160.
Date Treated : 17 October 1945. Test Insect: Anopheles quadrimaculatus.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF AIRCRAFT	NO. OF CAGES	NO. OF MOSQUITOES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF MOSQUITOES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF MOSQUITOES	PERCENT
31 Oct	Wiped	5	80	32.6	0	--	---	---	80/80	100.0
	Not Wiped	5	79	18.0	0	--	---	---	79/79	100.0
	BOTH	10	159	25.3	0	--	---	---	159/159	100.0

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CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-17
Serial No. : 993
Date Treated : 17 October 1945

Treatment : 200 mg sq ft.
Formulation : 6002-160
Test Insect : Housefly

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF FLIES	AVERAGE TIME (MIN) TO 100% KD	NO. OF CAGES	NO. OF FLIES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF FLIES	PERCENT
29 Oct	Wiped	5	76	34.8	0	—	—	—	76/76	100.0
	Not Wiped	5	87	22.6	0	—	—	—	87/87	100.0
	BOTH	10	163	28.7	0	—	—	—	163/163	100.0
29 Oct	Wiped	5	73	41.0	0	—	—	—	73/73	100.0
	Not Wiped	5	82	25.2	0	—	—	—	82/82	100.0
	BOTH	10	155	33.1	0	—	—	—	155/155	100.0
6 Nov	Wiped	6	90	23.6	0	—	—	—	90/90	100.0
	Not Wiped	6	86	19.1	0	—	—	—	86/86	100.0
	BOTH	12	176	21.4	0	—	—	—	176/176	100.0
14 Nov	Wiped	5	93	26.4	0	—	—	—	93/93	100.0
	Not Wiped	5	99	27.6	0	—	—	—	99/99	100.0
	BOTH	10	192	27.0	0	—	—	—	192/192	100.0
28 Nov	Wiped	4	50	59.2	1	16	2/16 = 12.5	3/16 = 18.8	53/66	80.2
	Not Wiped	5	61	31.8	0	—	—	—	61/61	100.0
	BOTH	9	111	44.0	1	16	2/16 = 12.5	3/16 = 18.8	114/127	89.6
3 Dec	Wiped	5	76	21.0	0	—	—	—	76/76	100.0
	Not Wiped	5	82	13.0	0	—	—	—	82/82	100.0
	BOTH	10	158	17.0	0	—	—	—	158/158	100.0
Summary	Wiped	30	458	33.1	1	16	2/16 = 12.5	3/16 = 18.8	461/474	97.4
	Not Wiped	31	497	23.1	0	—	—	—	497/497	100.0
	BOTH	61	955	28.0	1	16	2/16 = 12.5	3/16 = 18.8	958/971	98.6

CONSOLIDATION, RESIDUAL TOXICITY CAGE TESTS IN TREATED AIRCRAFT

Aircraft, Type: B-17. Treatment : 200 mg sq. ft.
Serial No. : 993. Formulation: 6002-160.
Date Treated : 17 October 1945. Test Insect: Anopheles quadrimaculatus.

		CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				TOTAL MORTALITY AFTER 24 HRS	
DATE OF TEST	TREATMENT OF MATERIALS	NO. OF CAGES	NO. OF ANOPHELES	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF ANOPHELES	% KD AT END OF CONTACT	% KILL AT END OF 24 HRS	NO. OF ANOPHELES	PERCENT
29 Oct	Wiped	5	94	19.2	0	—	—	—	94/94	100.0
	Not Wiped	5	96	19.0	0	—	—	—	96/96	100.0
	BOTH	10	190	19.1	0	—	—	—	190/190	100.0

Inclosure 17

COMPARISON, 2 HOUR KNOCKDOWN (KD) AND 24 HOUR KILL RATES
16 TESTS, HOUSEFLIES AND ANOPHELES QUADRIMACULATUS

	HOUSEFLIES			ANOPHELES
	CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD	CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD	SUMMARY	
No. of Cages	144	20	164	164
No. of Insects	2369	342	2711	3299
Minutes to 100% KD if under 2 hrs	37.1	--	--	33.8
KD at 2 hrs, %	100.0	4.1	88.4	100.0
24 hr kill rate, %	100.0	73.6	96.7	100.0

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CONSOLIDATION OF RESIDUAL TESTS, ALL AIRCRAFT, COMPARING FORMULATIONS
6002-160 AND DUPONT DEENOL 50-F

	CAGES SHOWING 100% KD BY END OF THE 2 HR CONTACT PERIOD			CAGES SHOWING LESS THAN 100% KD BY END OF THE 2 HR CONTACT PERIOD				KD AT END OF 2 HR CONTACT PERIOD	TOTAL MORTALITY AFTER 24 HRS	
	NO. OF CAGES	NO. OF INSECTS	AVERAGE TIME (MIN.) TO 100% KD	NO. OF CAGES	NO. OF INSECTS	KD AT END OF CONTACT	KILL AT END OF 24 HRS		NO. OF INSECTS	PERCENT
6002-160 Flies	340	5367	33.7	12	166	15/166 = 0.9%	100/166 = 60.2%	5382/5533 = 97.3%	5467/5533	98.7
Anopheles	44	877	34.9	0	0	---	---	877/877 = 100.0%	877/877	100.0
Deenol-50F Flies	249	3729	35.4	42	668	19/668 = 2.8%	474/668 = 70.8%	3748/4397 = 85.4%	4203/4397	95.7
Anopheles	120	2422	31.7	0	0	---	---	2422/2422 = 100.0%	2422/2422	100.0
TOTALS	753	12395		54	834				13019/13229	98.4

VARIOUS CONSOLIDATIONS, RESIDUAL TOXICITY
CAGE TESTS IN AIRCRAFT

HOUSEFLIES, 24-hour Kill Rates

Deenol 50-F

Cages on wiped surfaces,	2095/2289 flies = 91.5%
Cages on unwiped surfaces,	2108/2108 flies = 100.0%

6002-160

Cages on wiped surfaces,	2781/2847 flies = 97.7%
Cages on unwiped surfaces,	2686/2686 flies = 100.0%

Both Formulations

Cages on wiped surfaces,	4876/5136 flies = 94.9%
Cages on unwiped surfaces,	4794/4794 flies = 100.0%
Total, all cages	9670/9930 flies = 97.3%

CAGE TESTS, UNWIPED SURFACES, Average Time (minutes) to 100% KD

Deenol 50-F

No. Houseflies:	2108	Time: 23.03 minutes
No. Anopheles :	1183	Time: 22.46 minutes

6002-160

No. Houseflies:	2686	Time: 26.37 minutes
No. Anopheles :	439	Time: 21.26 minutes

Both Formulations

No. Houseflies:	4794	Time: 24.7 minutes
No. Anopheles :	1622	Time: 21.86 minutes

FLIGHT LOGS OF AIRCRAFT USED IN
RESIDUE TESTS

Periods covered are those from date of residual treatment of the aircraft until last test, cage or free-flight was made. Compare with Inclosure 14 "List of Aircraft... and Dates of Tests".

Aircraft: C-47 Serial No: 664 Date Treated: 4 October

Date	Hours Flight	Date	Hours Flight
9 Oct	3:50	2 Nov	4:15
11 Oct	1:00	7 Nov	4:30
12 Oct	5:05	8 Nov	4:40
15 Oct	4:20	15 Nov	4:30
16 Oct	4:25	16 Nov	4:25
17 Oct	4:20	20 Nov	5:00
18 Oct	5:00	21 Nov	7:50
20 Oct	5:15	28 Nov	4:35
26 Oct	4:30	4 Dec	5:30
27 Oct	4:15	5 Dec	1:30
30 Oct	9:20	8 Dec	4:55
1 Nov	4:20		

Total hours flight during test period: 107:20

Aircraft: C-47 Serial No: 070 Date Treated: 20 October

This aircraft was transferred away from the Base when these tests were made before its flight logs could be obtained; and all efforts to secure these data subsequently were unavailing. It is estimated that it was flown approximately as much as the other C-47, No. 664 (see above).

Aircraft: B-25 Serial No: 910 Date Treated: 6 October

Date	Hours Flight	Date	Hours Flight
11 Oct	6:50	3 Nov	4:20
12 Oct	4:20	4 Nov	2:40
14 Oct	5:20	5 Nov	2:10
15 Oct	4:15	6 Nov	4:20
18 Oct	4:20	7 Nov	5:55
19 Oct	4:25	15 Nov	2:30
30 Oct	5:35	16 Nov	3:35
31 Oct	3:30	17 Nov	4:15

Total hours flight during test period: 68:20

Aircraft: B-25 Serial No. 913 Date Treated: 11 October

Date	Hours Flight	Date	Hours Flight
22 Oct	1:35	24 Nov	2:45
24 Oct	10:40	25 Nov	4:15
26 Oct	14:20	29 Nov	1:00
16 Nov	6:10	20 Nov	5:00
17 Nov	2:00	2 Dec	5:00
18 Nov	5:25	3 Dec	3:10
20 Nov	1:00	4 Dec	7:30
21 Nov	2:05	8 Dec	5:45
23 Nov	2:15	10 Dec	3:50

Total flight hours during test period: 83:45

Aircraft: B-17 Serial No: 042 Date Treated: 2 November

Date	Hours Flight	Date	Hours Flight
15 Nov	2:40	30 Nov	3:20
16 Nov	12:10	30 Nov	5:30
18 Nov	10:15	2 Dec	5:10
27 Nov	:35	3 Dec	4:30
29 Nov	6:30	4 Dec	3:15

Total flight hours during test period: 53:55

Aircraft: B-17 Serial No: 993 Date Treated: 17 October

Date	Hours Flight	Date	Hours Flight
16 Oct ——	3:00	1 Nov ——	2:00
18 Oct ——	2:40	2 Nov ——	5:00
23 Oct ——	1:40	4 Nov ——	9:00
26 Oct ——	3:00	5 Nov ——	1:30
30 Oct ——	1:10	7 Nov ——	2:45

Total hours flight during test period: 31:45

Aircraft: B-17 Serial No.: 738 Date Treated: 17 October

Date	Hours Flight	Date	Hours Flight
30 Oct ——	1:15	28 Nov ——	1:45
14 Nov ——	1:45	29 Nov ——	4:10
19 Nov ——	5:50	30 Nov ——	3:30
21 Nov ——	1:40	4 Dec ——	4:50
22 Nov ——	6:35	5 Dec ——	2:00
25 Nov ——	5:25	6 Dec ——	8:20
26 Nov ——	1:20	7 Dec ——	3:45
27 Nov ——	5:20		

Total hours flight during test period: 57:30

Inclosure 21

RECORD OF DISPERSIBLE DDT RESIDUE TESTS IN AIRCRAFT

TYPE	SERIAL	SPRAYED	FORMULATION	CONC. SQ.FT.	*DATES OF TESTS
C-47	070	2 Oct	Deenol-50F	200 mg	OCT 12-18-19-30-31 NOV 1-2-9-16-27-27 DEC 4-4-11
C-47	664	4 Oct	Deenol-50F	200 mg	OCT 22-22-23-23-24-25-29-29 NOV 13-29-29 DEC 10
B-25	910	6 Oct	Deenol-50F	200 mg	OCT 16-22-22-23-23-24-25 NOV 20-23 DEC 5-7
B-25	913	11 Oct	6002-160	200 mg	OCT 15-16-18-19-30-30 NOV 5-6-7-9-19-21-27-27 DEC 11
B-17	042	2 Nov	6002-160	100 mg	NOV 6-7-8-9-13-13-19-21-26-26 DEC 7-7
B-17	738	17 Oct	6002-160	200 mg	OCT 31 NOV 1-1-2-5-7-8-9-16 DEC 10
B-17	993	17 Oct	6002-160	200 mg	OCT 29-29 NOV 6-14-15-28-28 DEC 3-3-3

* Dates underlined represent "free flight" tests, others are cage tests.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: B-17
serial no.: 042

TREATMENT, date: 2 Nov 45
formulation: 6002-160
concentration: 100 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURE HIGH	TEMPERATURE LOW
19 Nov.	3	15	60	60	4000	95°	85°
21 Nov.	5	19	60	60	5000	86°	77°
26 Nov.	11	13	75	75	5000	90°	76°
7 Dec.	11	13	45	45	5000	70°	54°
Totals & Averages	7.5	15	60	60	19,000	85.2°	73°

* Figures are in minutes after release of flies in aircraft.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: B-17
serial no.: 738

TREATMENT, date: 17 Oct 45
formulation: 6002-160
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURE HIGH	TEMPERATURE LOW
16 Nov.	5	11	90	90	5000	75°	72°
10 Dec.	8	10	45	45	5000	80°	60°
Totals & Averages	6.5	10.5	67.5	67.5	10,000	77.5°	66°

* Figures are in minutes after release of flies in aircraft.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: B-17
serial no.: 993

TREATMENT, date: 17 Oct 45
formulation: 6002-160
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURE HIGH	LOW
28 Nov.	19	21	60	60	5000	82°	69°
3 Dec.	6	7.5	30	30	5000	86°	71°
3 Dec.	7	13	45	45	5000	91°	80°
Totals & Averages	10.6	13.8	45	45	15,000	86.3°	73.3°

* Figures are in minutes after release of flies in aircraft.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: B-25
serial no.: 913

TREATMENT, date: 11 Oct 45
formulation: 6002-160
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURES HIGH	LOW
19 Nov.	10	12	60	60	4000	86°	74°
21 Nov.	5	13	75	75	5000	102°	89°
27 Nov.	13	16	90	90	4000	101°	85°
Totals & Averages	9.3	13.6	75	75	13,000	96.3°	82.6°

* Figures are in minutes after release of flies in aircraft.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: B-25
serial no.: 910

TREATMENT, date: 5 Oct 45
formulation: Du Pont Deenol-50F
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURE HIGH	LOW
25 Oct.	8	12	75	120	6000	95°	82°
20 Nov.	5	10	60	60	2000	60°	75°
23 Nov.	8.5	15	45	45	5000	75°	61°
Totals & Averages	7.2	12.3	60	75	13,000	76.6°	72.6°

* Figures are in minutes after release of flies in aircraft.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: C-47
serial no.: 070

TREATMENT, date: 2 Oct 45
formulation: Du Pont Deenol-50F
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURE HIGH	TEMPERATURE LOW
16 Nov.	4	10	120	—	5000	76°	74°
27 Nov.	18	21	45	120	5000	84°	62°
4 Dec.	7	11	45	75	5000	75°	60°
11 Dec.	5	7	45	75	5000	96°	81°
Totals & Averages	8.5	12.25	63.7	—	20,000	82.7°	69.2°

* Figures are in minutes after release of flies in aircraft.

NOTE: Test of 16 Nov.; 10 flies not knocked down at end of 2 hours contact; all died within 12 hours.

CONSOLIDATION, FREE-FLIGHT TESTS IN
RESIDUAL-TREATED AIRCRAFT ON GROUND

AIRCRAFT, type: C-47
serial no.: 664

TREATMENT, date: 4 Oct 45
formulation: Du Pont Deenol-50F
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DATE OF TEST	*FIRST EFFECT	*FIRST KD	*100% AFFECTED	*100% KD	NO. FLIES RELEASED	TEMPERATURE HIGH	LOW
29 Nov.	16	18	45	60	5000	74°	61°

* Figures are in minutes after release of flies in aircraft.

FREE FLIGHT TEST IN DDT-RESIDUE
TREATED AIRCRAFT IN FLIGHT

AIRCRAFT, type: B-17
serial no: 042

TREATMENT, date: 2 Nov 1945
formulation: 6002-160
concentration: 100 mg sq ft.

TEST INSECT: Housefly

DURATION OF CONTACT PERIOD: 120 min.

DATE OF TEST: 17 Dec 1945

TEMPERATURE, high: 53°
low: 48°

NO. OF FLIES RELEASED: 5000

* FIRST AFFECTED FLY NOTED: 19 min.

* FIRST KNOCKED DOWN FLY NOTED: 24 min.

* 100% OF FLIES AFFECTED: 30 Min.

* 100% OF FLIES KNOCKED DOWN: 75 min.

% MORTALITY AFTER 24 HRS: 100%

* Figures are in minutes after release of flies in aircraft.

FREF FLIGHT TEST IN DDT-RESIDUE
TREATED AIRCRAFT IN FLIGHT

AIRCRAFT, type: C-47
serial no.: 664

TREATMENT, date: 4 Oct 1945
formulation: DuPont Deenol-50F
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DURATION OF CONTACT PERIOD: 120 min.

DATE OF TEST: 6 Dec 1945

TEMPERATURE, high: 72°
low: 61°

NO. OF FLIES RELEASED: 6000

* FIRST AFFECTED FLY NOTED: 12 min.

* FIRST KNOCKED DOWN FLY NOTED: 19 min.

* 100% OF FLIES AFFECTED: 1 hr.

* 100% OF FLIES KNOCKED DOWN: 1 hr. 15 min.

% MORTALITY AFTER 24 HRS: 100%

* Figures are in minutes after release of flies in aircraft.

FREE FLIGHT TEST IN DDT-RESIDUE
TREATED AIRCRAFT IN FLIGHT

AIRCRAFT, type: C-47
serial no.: 070

TREATMENT, date: 2 Oct 1945
formulation: DuPont Deenol-50F
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DURATION OF CONTACT PERIOD: 120 min.

DATE OF TEST: 17 Dec 1945

TEMPERATURE, high: 70°
low: 69°

NO. OF FLIES RELEASED: 5000

* FIRST AFFECTED FLY NOTED: 8 min.

* FIRST KNOCKED DOWN FLY NOTED: 10 min.

* 100% OF FLIES AFFECTED: 1 hr. 30 min.

* 100% OF FLIES KNOCKED DOWN: 1 hr. 45 min.

% MORTALITY AFTER 24 HRS: 100%

* Figures are in minutes after release of flies in aircraft.

FREE FLIGHT TEST IN DDT-RESIDUE
TREATED AIRCRAFT IN FLIGHT

AIRCRAFT, type: B-25
serial no.: 910

TREATMENT, date: 5 Oct 1945
formulation: DuPont Deenol-50F
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DURATION OF CONTACT PERIOD: 120 min.

DATE OF TEST: 6 Dec 1945

TEMPERATURE, high: 74°
low: 62°

NO. OF FLIES RELEASED: 5000

* FIRST AFFECTED FLY NOTED: 8 min.

* FIRST KNOCKED DOWN FLY NOTED: 14 min.

* 100% OF FLIES AFFECTED: 1 hr.

* 100% OF FLIES KNOCKED DOWN: 1 hr. 30 min.

% MORTALITY AFTER 24 HRS: 100%

* Figures are in minutes after release of flies in aircraft.

FREE FLIGHT TEST IN DDT-RESIDUE
TREATED AIRCRAFT IN FLIGHT

AIRCRAFT, type: B-17
serial no.: 993

TREATMENT, date: 17 Oct 1945
formulation: 6002-160
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DURATION OF CONTACT PERIOD: 120 min.

DATE OF TEST: 18 Dec 1945

TEMPERATURE, high: 78°
low: 62°

NO. OF FLIES RELEASED: 3000

* FIRST AFFECTED FLY NOTED: 9 min.

* FIRST KNOCKED DOWN FLY NOTED: 12 min.

* 100% OF FLIES AFFECTED: 1 hr. 30 min.

* 100% OF FLIES KNOCKED DOWN: 1 hr. 45min.

% MORTALITY AFTER 24 HRS: 100%

* Figures are in minutes after release of flies in aircraft.

FREE FLIGHT TEST IN DDT-RESIDUE
TREATED AIRCRAFT IN FLIGHT

AIRCRAFT, type: B-17
serial no.: 738

TREATMENT, date: 17 Oct 1945
formulation: 6002-160
concentration: 200 mg sq ft.

TEST INSECT: Housefly

DURATION OF CONTACT PERIOD: 120 min.

DATE OF TEST: 27 Nov 1945

TEMPERATURE, high: 85°
low: 74°

NO. OF FLIES RELEASED: 4500

* FIRST AFFECTED FLY NOTED: 6 min.

* FIRST KNOCKED-DOWN FLY NOTED: 17 min.

* 100% OF FLIES AFFECTED; 45 min.

* 100% OF FLIES KNOCKED DOWN: 1 hr. 15 min.

% MORTALITY AFTER 24 HRS: 100%

* Figures are in minutes after release of flies in aircraft.

Fig. 1. Mosquitoes Taken From B-29 Aircraft. The mass of mosquitoes shown here were swept up from the two side blisters of a B-29 aircraft which had been standing in the open at Pinecastle AAF, Florida in August, 1945. The aircraft had been heavily treated with the DDT aerosol dispenser. These were probably much less than half of the total number in the airplane. (See text, Sec. IV, par 1 (2) (a)).

AIRCRAFT DISINSECTIZATION NOTES

Excerpts From Report of Temporary Duty in
Caribbean Area and Brazil, December - January 1946,
Captain Alexander B. Klots, SnC

1. Miami, Florida. In a long discussion with a Medical Corps Captain who had served at Atkinson Field, British Guiana for several months, a number of important points were learned as follows:

a. Disinsectization provisions of regulations were frequently ignored. Many times there was no aerosol treatment of airplanes; when there was treatment it was usually given in the air after take off or before landing. Air Force personnel were usually uncooperative in disinsectization procedures.

b. The Quarantine Units at the various Caribbean Bases functioned in disinsectization to some degree, but spasmodically, and then merely to spray a plane after it had landed and its doors had been opened.

c. Ground control of Anopheles was usually very good; but in many cases there is considerable agriculture near runways, and at Atkinson Field a native village is close to the edge of the air field. Thick jungle growths with Bromeliad plants and Anopheles bellator also are found close to air strips.

2. Miami AAF to Borinquen Field, Puerto Rico. The C-54 transport plane presents a number of special problems. The baggage compartment between the crew's quarters and the main cargo-passenger compartment has a large cupboard with sliding doors that is ideal for hiding insects. The bunks in the crew's quarters and cupboards there and in the rear of the main passenger compartment all furnish excellent hiding places for insects and must be conscientiously treated with aerosol. The interior of the main passenger compartment is lined with a painted, snap-on cloth lining which is pierced by many holes through which insects can easily go to hide behind the lining. Behind this they will be almost entirely safe from aerosol treatment; they can be controlled only by a thorough residual treatment behind the entire lining.

A housefly was observed in the passenger compartment during the entire trip. Nearly all of its time was spent on the upholstered seats and in feeding on the hair-oil on a Puerto Rican soldier, a locality not well adapted for residual DDT treatment.

3. Borinquen Field, Puerto Rico. Discussed problems with Operations Officer, 330th Transport Squadron. This officer confirmed reports on disinsectization that the job was usually done, if at all,

in flight, usually before a landing. He admitted that little effort was made to distribute aerosol spray carefully or to time its release. He stated that when high ranking officers were riding in the plane aerosol spraying was often omitted because of their protests.

Met and inspected a C-54 plane in from Casablanca, Brazil and British Guiana. Two passengers stated that the plane had received no aerosol treatment. One dead butterfly of the African genus Pieris was found in the passenger compartment; otherwise no insects were seen. The plane contained much cargo between which were many spaces in which insects could hide while resting on the cargo and could thus be controlled only with aerosol treatment. Some of the cargo was covered over with canvas; residual treatment of this canvas would be advantageous.

4. Borinquen Field, Puerto Rico. Inspected Borinquen Air Field and its surroundings and photographed some features. Many of the parking stands for airplanes are within 100 yards of fields of sugar cane just outside the Base fence or of thick growths of scrub and palms. When there was much traffic through this airport and planes were parked on these spaces, it would have been very easy for insects to enter the planes. At present, with small traffic, the planes are all parked near the hangars where there is little vegetation other than grass, palm and almond trees. The Air Field proper is kept well mowed. Ditches immediately around the Air Field are dry.

In the afternoon called on Captain J. A. Echegaray, V. C., the Post Medical Inspector. With him visited the native village of San Antonio with many primitive huts within a quarter of a mile of the Air Field, and Bajura Pond, a small pond and marsh on the Base but below the sea-cliff. In San Antonio every hut has a 50-gallon water container, all of which were breeding Aedes aegypti and Culex quinquefasciatus mosquitoes by the thousands and formed an abundant source of supply of these mosquitoes very close to the airport and base. Since this village is off the base, previous efforts on the part of Base personnel to exercise insect control in it had met with no success. It is a dangerous spot which should however, be controlled. Living conditions of the natives are extremely primitive and filthy. Bajura Pond was found to be breeding Anopheles, although larvae taken were too small for identification. Base records show Anopheles albimanus, grabhami and vestitipennis, as well as 12 species of Culicine mosquitoes. Relatively few Anopheles have been recorded in the inhabited parts of the Base, one fourth to one half mile from the pond, by the top of the sea-cliff; nevertheless it is believed that this breeding place, especially in view of the close proximity of San Antonio represents a source of danger both to Base personnel and of mosquito entrance into airplanes, which should be thoroughly controlled.

5. Atkinson Field, British Guiana. At Atkinson Field a large sign in Base Operations reads "All airplanes will be sprayed with an airsol

(sic!) bomb before landing and take off." However, no spraying was done. A housefly was noted active in the plane during the trip Atkinson to Belem. Before taking off from Belem the plane was treated with a pyrethrum aerosol bomb for approximately 10 seconds, all doors and port holes being open at the time. A housefly, probably the same that had come from Atkinson, remained in the plane to Natal, as did three Halictid bees, one Syrphid fly (Volucella sp.) and a number of Drosophilid flies.

Enroute discussed disinsectization with pilot and navigator. They said they generally gave aerosol treatment, if at all, after take off and before landing. They did so about five minutes before landing at Natal, the flight engineer doing the job. He was obviously totally unfamiliar with the aerosol bomb and had to be shown how to use it. He sprayed for at most two seconds in the pilot, navigator, radio, crew's and fuels sections combined. He then hastily walked through the passenger compartment giving it an inadequate treatment of approximately 10 seconds. Many of the port holes were open, making the treatment thoroughly ineffective.

6. Parmamirim Field, Natal, Brazil. The country around Parmamirim Field is extremely arid and sandy with a growth scrub. Two small ponds on the Base are inspected daily and sprayed at least weekly although no mosquito breeding of importance has been found in them. Ditches are all in good condition and vegetation has been cut well back from the Air Field so as to offer no harborage for insects. Inspected a river bottom at Fazenda de Giqui about five miles from the Base, where Anopheles albitarsis occur in spite of ditch work by the National Malaria Service. This is, however, outside of the danger zone around the Base.

7. Rio de Janeiro, Brazil. In conference with Dr. Kumm at the Rockefeller Foundation considerable time was spent discussing the need for disinsectization. Dr. Kumm showed me the manuscript of an article which the Rockefeller Foundation will shortly publish containing complete records of all insects picked up on planes coming to Brazil from Africa and sent to the Rockefeller Foundation for identification. Large numbers of Anopheles gambiae have consistently been sent as well as thousands of other mosquitoes and other insects of nearly all orders. The list includes Glossina palpalis, a tsetse fly. Species of mosquitoes from Africa are most abundant but some from Central America and the Antilles were found, even Anopheles crucians. There were many Mansonia, Aedes taeniorhynchus, sollicitans and aegypti. Some of the specimens undoubtedly remained in the planes during the trip from North America and the Antilles through Brazil, across the South Atlantic to Accra and Casablanca and then back to Brazil. It is the opinion of the Rockefeller Foundation and of the Brazilian Government that something still further must be done to carry on more effective disinsectization of aircraft. In this respect, it is noteworthy, Aedes aegypti has, after much labor and expense, been exterminated in many Brazilian cities. There is

danger of reintroducing this species from North America or the Antilles. This danger appears to be a real one in view of the proximity of large amounts of aegypti breeding, noticed at Borinquen Field.

8. Rio de Janeiro to Natal, Brazil. On leaving Rio about 150 houseflies and at least one Chironomid and two mosquitoes were observed in the plane. During flight at altitude 8,000 feet, 15 seconds spraying was given with all port holes closed. The majority of the flies were knocked down in about five minutes, but several were unaffected and alive at the end of the flight. The Chironomid and the two mosquitoes were all observed alive and unaffected at least two hours after the spraying. One of the mosquitoes, Culex nigripalpus Theobald, was captured four hours after spraying. The treatment, which equals in amount of spray that required by AAF Regulation 61-3, was obviously inadequate.

9. Natal to Belem, Brazil. A Chironomid remained in the plane all the way from Natal to San Luiz. About 25 houseflies boarded the plane at San Luiz and accompanied it to Belem. A Culicine mosquito, (Psorophora ferox (Humboldt)) bit Captain Klots on the leg at about 8,000 feet altitude between San Luiz and Belem. It then flew up and lit on the plexiglas window.

10. Belem, Brazil to Miami, Florida. No disinsectization treatment or precautions were taken during the entire trip. About 25 houseflies were present in the plane during the entire trip; many of them probably were the same flies all the way. Although some authorities question the importance of houseflies in disinsectization of aircraft, it must be remembered that the housefly is a proven carrier of dysentery, both bacillary and amebic, as well as a suspected carrier of poliomyelitis. In view of the great abundance of dysentery in Brazil and Africa, it is probable that some of these flies were carrying infection to the United States.

HEADQUARTERS ANTILLES DEPARTMENT
APO 851, c/o PM, Miami, Fla

28 June 1944

MEMORANDUM)
:
NUMBER 64)

SECTION I: DISINSECTIZATION PROCEDURES
SECTION II: QUARANTINE MEASURES

The following instructions from this Headquarters are published for the information and guidance of all concerned:

SECTION I

SUBJECT: DISINSECTIZATION PROCEDURES

1. All Army aircraft and such other aircraft proceeding from Base to Base in this Command, whose point of origin and destination is confined to islands of the Caribbean, will not be subjected to quarantine measures or disinsectization procedures with exception of Trinidad.

2. All Army aircraft and such other aircraft whose origin of flight has been from a Base on the South American Continent, from the Island of Trinidad, European, African theater, or Central America excluding Canal Zone, will be subjected to quarantine measures or disinsectization procedures at their first point of call in this command and upon arrival in United States Territory, as per paragraph 6, below. There will be no further disinsectization procedures carried out after this, and the plane will proceed on a "Base to Base" status as indicated in paragraph 1. (Continent of South America is meant to mean mainland and does not include Aruba, Curacao, or adjacent islands).

3. Aircraft arriving from United States will not be subjected to disinsectization procedures at any Base under this command.

4. The responsibility of disinsectization will be vested with the pilot of each aircraft. It is his duty as specified in AAF Regulation 61-3, paragraphs 5 and 6, to carry adequate supplies of Aerosol for use in disinsectization. All pilots should be familiar with AAF Regulation 61-3, dated 4 October 1943.

5. In emergencies and in epidemic periods, the Commanding General, Antilles Department, will immediately notify all Bases under his command and emergency measures may be instituted wherever and whenever deemed necessary by the Commanding General, Antilles Department.

SECTION I (CONT'D)

6. The routine for disinsectization is as follows:

a. One half hour before plane lands, it should be sprayed with Aerosol for a period of two minutes according to Army Regulations.

b. All Army aircraft having contact with endemic areas of insect-borne disease will be disinsectized in accordance with current regulations of the Foreign Quarantine Division, US Public Health Service. Disinsectization procedures will be accomplished prior to departure and immediately upon arrival at destination. Aircraft will be disinsectized using Aerosol Insecticide (QM issue, Stock No.51-I-159) or a substitute insecticide, as outlined in paragraph 7, below. All doors, windows and other openings will be closed during the period of spraying and the aircraft will remain closed for a period of two minutes subsequent to spraying. All inclosed spaces of the aircraft must be sprayed, including wheel nacelles, which will be sprayed prior to departure. Each aircraft departing from the continental limits of the United States coming in contact with infected areas will be equipped with one or more Aerosol containers, depending upon the type of aircraft. The commander of an air echelon will be responsible for the requisition and installation of Aerosol containers. In the instances of travel of single aircraft, the pilot of the aircraft will have this responsibility. Supplies of Aerosol containers for replacement purposes will be maintained at AAF stations serving as ports of embarkation and such stations of Air Transport Command ferrying routes as are located in areas of insect-borne diseases.

c. Disinsectization of Army aircraft is a command responsibility. It will be a Medical Department responsibility of each Air Base concerned to provide trained personnel for instruction of aircrew members in disinsectization of aircraft upon call of unit or base commanders.

7. The dosage for eliminating infectious mosquitoes from various types of military aircraft - Aerosol method. Ground treatment - planes should be kept closed for two minutes after application. Basic dosage 10 grams solution per 1000 cu. ft. *

Plane Type	Volume	Planes of the same series and of about the same size.	Variance of volume within series.	Dosage Spray Time **

SECTION I (CONT'D)

(Flying Fortress B-17	1738	C-39, C-42, C-46 C-53, B-24, B-33, B-34, B-28	All of about the same size	30
(Boeing) B-29	5000	B-32, C-54, C-55	All of about the same size	90
(North American Light Bomber) B-25	1490	B-26, B-23, B-18, A-20, C-67, A-26, A-28, A-24, A-29, C-40	Considerable, From 850 for A-20 and C-40 to 1490 for B-25	15-27
(Fighter) P-40	175	P-39, P-38, P-43, P-51, P-66	175 - 225	3-4

NOTE: Wing size of these planes: Fighters - 150 - 500 cu. ft.
Bombers & Commercial - 700-4,000 cu. ft.

*Aerosol Insecticide Dispenser (QM Issue, Stock No. 51-I-159).
**Spray time figures using the one-pound "Bomb Type" container that delivers approximately one pound of insecticidal solution in 13-14 minutes.

DIRECTIONS

A - Use of Aerosol

1. To operate dispenser, bend capillary tube backwards and forwards until it breaks off at the base.

2. The aerosol is then automatically discharged.

3. Walk from the rear of the ship to the pilot's compartment spraying the aerosol into the air. Open all compartments and spray into them.

SECTION I (CONT'D)

4. Do not hold closer than one foot to any stainable articles.

5. The number of seconds to spray are: B-17 series - 30 seconds; C-54 series - 90 seconds; B-25 series - 15-27 seconds; and P-40 series - 3-4 seconds.

6. Then invert dispenser, nozzle down, so that only gas is sprayed and screw on temporary cap.

7. For further use remove temporary cap and proceed as above.

B-Pyrethrum Method. (Alternate)

1. That standardized pyrethrum extract or concentrate designated by the several firms marketing it as pyrethrum concentrate, 20 to 1 strength; pyrethrum extract standardized; pyrethrum extract No. 20; pyrethrum concentrate No. 20; and No. 20 extract standardized; contains 2 grams of pyrethrins per 100 cubic centimeters of deobase or other approved vehicle. The insecticide has a very low flash point, is non-staining and non-corrosive, and, except for being mildly irritating to the skin on direct application, is harmless to humans in the concentration used. As the efficacy of the insecticide depends largely on the degree of vaporization secured in spraying, the vaporizor or handspray producing the smallest droplets (densest cloud of mist) is the most satisfactory. Approved insecticide and hand sprayers may be obtained from the local Quartermaster.

SECTION II

SUBJECT: QUARANTINE MEASURES

1. The Air Base Commander at each base under jurisdiction of the Antilles Department will appoint a Medical Officer to act as Quarantine Officer. This officer will be responsible to see that either himself or a substitute Medical Officer is on hand when airplanes arrive from fields as mentioned in Section I, paragraphs 1 and 2.

2. Air Base Commanders of this Command will be responsible for compliance with operating procedure noted in Army Air Forces Regulations 61-3, dated 4 October 1943.

SECTION II (CONT'D)

a. The Operations Office of each Air Base in this Command will instruct the pilots of incoming planes subject to quarantine that spraying is to be done 30 minutes before landing.

b. In the event that a plane is not sprayed prior to arrival, passengers and crew will remain aboard that plane until it is sprayed, and for two (2) minutes thereafter. Spraying will be done promptly on arrival.

c. Briefing officers of this Command will include in their briefing instructions to plane crews, a reminder of their responsibility tc carry Aerosol insecticide in their planes and perform the required disinsectization.

3. The Quarantine Officer or his representative will see each passenger personally. Temperatures need not be taken unless the person is obviously ill or has complained of feeling ill. When there is an elevation of temperature or other reason to suspect infectious disease in any person examined, this person will be detained in quarantine on the base until final diagnosis is made.

4. The examination of passenger and crew members by the Quarantine Officer or his representative and assistants will be done expeditiously and with courtesy and tact so that the delay will be as short as possible. Distinguished personnel and crew members will be examined first. All personnel will be examined regardless of time or arrival or length of stay. The Quarantine personnel will be on hand when the airplane lands so that no delay will be experienced by passenger or crew members on account of late arrival of Medical personnel.

5. All parrots or parrot-like birds will be removed from airplanes and destroyed. Transmission of all animals, birds, fruits, and vegetables will be discouraged. In the event animals, plants or fruits are aboard, they will not be removed but will remain in the airplane while the spraying is done. Any sick animal will be removed and examined.

6. A Quarantine-Disinsectization Officer shall be appointed at each Air Base and shall submit to Headquarters Antilles Department semi-monthly, a report as attached. This report will be classified SECRET.

By command of Major General SHEDD:

OFFICIAL:
/s/ E. W. Dennis
Colonel, ADG
Adjutant General

T. R. PHILLIPS
Brig.Gen.,GSC
Chief of Staff

DISTRIBUTION: "A"
1 Incl: Semi-Monthly Report Form
Inclosure 25, No. 1

HEADQUARTERS
UNITED STATES ARMY FORCES SOUTH ATLANTIC
APO 676, c/o Postmaster
Miami, Florida

12 November 1943

MEMORANDUM)
:
NO 83)

DISINSECTIZATION OF AIRCRAFT

1. With the concurrence of the Commanding General, SAW, ATC, all previous directives and instructions relative to Disinsectization of Aircraft, issued either by SAW, ATC or USAFSA, are hereby rescinded.

2. Pending receipt of new directives and regulations from the War Department, the following provisions for the Disinsectization of Aircraft are published for the information and guidance of all concerned, and become effective at once.

3. Disinsectization of aircraft arriving in Brazil from Africa directly or via Ascension Island:

a. The Brazilian Government in collaboration with the United States Army Forces in Brazil has assumed responsibility for the Disinsectization of all aircraft arriving on bases used by the United States Army in Brazil.

b. All concerned will comply strictly with the requirements of the Brazilian Decree-Law 5181, dated 11 January 1943.

c. The Expected Time of Arrival (ETA) of all planes enroute to Brazil from Africa, either direct or via Ascension Island, will be made readily available by the Operations Officer to those responsible for disinsectization.

d. The Control Tower Operators will notify planes at first radio contact prior to their landing, that they are to come in with all windows, ventilators and window plugs closed so that planes will land in a completely sealed condition, preventing escape of insects. Notification will also be given at this time that plane will be thoroughly disinsectized in accordance with Brazilian laws.

e. Immediately upon landing the planes will taxi so as to be in a position easily accessible to the Brazilian health authorities who

will then board the plane in order to carry out the disinsectization which consists of spraying with Aerosol bombs, and collection of insects. No one is to interfere in any way with their routine disinsectization procedures.

f. Passengers and crew will remain in the plane and will not attempt to disembark until given permission to do so by the Medical Department officer in charge, following the disinsectization by the Brazilian crew. This prevents possible escape of insects before the ship is thoroughly disinsectized.

g. The pilot will present to the Medical Department Officer a Disinsectization Certificate obtained in Africa, properly signed and in accordance with letter dated 28 October 1943, Headquarters African-Middle East Wing, ATC (125.11) Subject: "Disinsectization of Aircraft".

h. Personnel violating the Brazilian Decree-Law will be advised that they are liable under the provisions of this Law and a report will immediately be made by the Medical Department officer in charge to the Commanding General, USAFSA, and to the Base Commander, in each instance.

4. Disinsectization of aircraft arriving on Ascension Island enroute to Brazil from Africa:

a. Disinsectization will be performed under the supervision of the Senior Medical Officer of the command.

b. The Operations Office will keep the disinsectization crews informed regarding the Expected Time of Arrival (ETA) of westbound planes enroute to Brazil so that each plane can be met and disinsectized.

c. Control Tower will notify planes prior to landing that all windows, ventilators and side-window plugs are to be closed so that planes will land in a sealed condition.

d. Disinsectization crews will board the planes and using aerosol bombs, completely spray the interior compartments from pilot's compartments to rear, including toilets, kitchens, under seats, around life-saving equipment, and baggage compartments; taking no less than the time shown in Appendix 1 of AAF Regulation 61-3, dated 4 October 1943, for this spraying. Following this, the plane will remain closed for a period of no less than five minutes in order to allow the aerosol to diffuse throughout the interior of the ship. No persons will disembark from the plane until after this five minute period has elapsed.

e. No Disinsectization Certificates (see paragraph 3 g above) will be presented or accepted at Ascension Island, but pilots will be advised to hold them in order to present them upon arrival at a Brazilian base.

5. Disciplinary action, in accordance with existing military and civil regulations, will be taken against those who fail to comply with the provisions of this order and with the Brazilian-Decree Law.

By command of Major General WALSH:

/s/ F. B. O'DONNELL
Lieut. Colonel, AGD
Adjutant General

DISTRIBUTION:

A, B, C
Surgeon - 15 copies.

HEADQUARTERS
U. S. ARMY FORCES
APO #604 c/o Postmaster
Miami, Florida

28 September 1943

CIRCULAR)
: Standard Operating Procedure for Disinsectization of Aircraft
NO 11-2)

1. The men assigned to this detail will be divided into three groups, each serving an eight hour tour of duty. Sufficient men will be assigned to provide for two men to inspect the spraying of each plane.

2. Upon arrival of a plane from Africa, the two men will enter the plane with the Brazilian spray crew. During the Preliminary investigation for live insects the men will observe carefully any capture of live insects and will verify immediately the identification of live Anopheles gambiae mosquitoes found.

3. After the plane has been sprayed the men will observe closely the search made by the Brazilian crew for dead or living insects. Verification of the identification of Anopheles gambiae found dead or alive, will be made on the spot. Live mosquitoes will be defined as those showing active wing or leg movements.

4. The pilot of the plane or a responsible crew member will be interrogated by one of the detail in the plane, as to whether the plane was sprayed prior to departure or enroute.

5. A permanent record of the spraying and inspection of the plane will be made immediately following the completion of inspection. This record will be kept in the ledger provided for the purpose. This record will include the following data: Date, Number of plane, Type of plane, Place of departure, Time of arrival (local time), Number of mosquitoes found (living and dead in the following classification, Anopheles gambiae, other anophelines, culicines), Remarks concerning previous spraying, and initials of one of the men making the inspection.

6. At the end of each day a written report will be made to the Base Surgeon by the Officer in Charge. This report will contain the information on each plane which was recorded in the ledger for that day. Copies of each daily report will be forwarded each week to the Surgeon, USAFSA.

7. Any unusual occurrences, such as the arrival of live Anopheles gambiae, will be reported in detail by radio to the Surgeon, USAFSA.

By order of Major HOUSE:

JOHN BECK
2nd Lt., AC
Asst. Adjutant

OFFICIAL:
/s/ John Beck
JOHN BECK
2nd Lt., AC
Asst. Adjutant

DIST: "C"

1254th AAF BASE UNIT
NORTH AFRICAN DIVISION
Air Transport Command

OPS/HHJ/alm

1. Your attention is directed to:

(a) Section 4, AAF Regulation No. 61-3, dated 4 October 1943, requiring disinsectization of aircraft.

(b) The Brazilian Decree Law No. 5181, dated 11 January 1943, governing the importation of insects, e.g., mosquitoes, into Brazil. A copy of this decree law is posted on the bulletin board in Operations.

2. You are ordered to land your plane in Brazil in A COMPLETELY SEALED CONDITION.

3. A COMPLETELY SEALED CONDITION means that the plane shall be landed with all BOMB BAYS, doors, windows, hatches, and other openings sealed, to the end that no insects can escape from the plane.

4. After you land your plane, you shall open the plane only for the entry of the Brazilian authorities, and shall immediately thereafter close the plane, and keep it sealed until the disinsectization authorities of Brazil have accomplished the complete disinsectization of the plane. Disinsectization embraces (1) spraying, and (2) the settling period, which is set, in each instance, by the Brazilian authorities only.

5. The Brazilian authorities alone shall open the plane after disinsectization. The pilot is not authorized to open the plane.

6. B-29's only (repeat) only may land and open bomb bays. However, the pressure-tight hatches into the bomb bays shall remain closed to the end that the remainder of the plane shall be completely sealed. All other requirements of this memorandum apply to B-29's.

7. The pilot shall require each member of his crew, and passengers, if any, to read these orders before takeoff, and comply herewith.

8. Any violation of these orders by yourself, your crew or passengers, will result in immediate disciplinary action.

BY ORDER OF COLONEL FRASER:

/s/ Harold H. Jones, Jr.
HAROLD H. JONES, JR.
Major, Air Corps
Director of Operations

I certify that I have carefully read the foregoing disinsectization order and that I shall require each person on my plane to read these orders before takeoff.

_____
Pilot

HEADQUARTERS
SOUTH ATLANTIC DIVISION, AIR TRANSPORT COMMAND
c/o Postmaster, Miami, Florida

DIVISION REGULATION) 10 June 1945
NUMBER 25-2)

FLYING

Disinsection and Quarantine

(This Regulation supersedes Division Memorandum 60-1, 16 August 1944)

I. DISINSECTION OF AIRCRAFT - (Reference AAF Reg 61-3, ATC Memo 25-11, Brazilian Decree Law 5181)

1. General - Aircraft disinsection is accomplished for purpose of preventing transmission of disease bearing insects from one area to another. Disinsection by aircraft crews will be accomplished in manner outlined in Paragraph 13, Section IV of AAF Regulation 61-3 dated 9 August 1944.

2. Brazilian Requirements - Brazilian Decree Law 5181 requires disinsection of all aircraft which have touched any part of African Continent upon arrival in Brazil. Such disinsection is accomplished by Brazilian health officials at first port of entry into Brazil. In order to insure compliance with Brazilian law the following steps are required of personnel concerned:

a. ETA of all aircraft enroute to Brazil from Africa will be furnished to station disinsection teams prior to arrival of aircraft.

b. Pilot will be notified by radio before landing that all windows, doors, ventilators, etc., are to remain closed and that all personnel are to remain aboard until aircraft is cleared by Brazilian disinsection official.

c. Pilot will deliver the certificate of disinsection furnished him in Africa to the disinsection team which will board the plane at port of arrival in Brazil.

d. Prompt disciplinary action will be taken against pilots or crew members who violate provisions of the Regulation by opening any of aperatures or disembarking before permission is granted by Brazilian health official.

3. South Atlantic Division Requirement:

a. Aircraft departing from stations of the Division for destinations in United States, Caribbean Ascension, or in Africa will be disinsected by crew member under direction of pilot prior to take off at last stopping point in Brazil.

b. Aircraft coming to Brazil from Africa via Ascension will be disinsected prior to departure from Ascension.

c. Certification of accomplished disinsection will be entered in Clearance (AAF Form #20 or its equivalent) of the Aircraft. Completion of disinsection will be signaled to the control tower. Aircraft will not be cleared for take-off until the disinsection has been indicated to the control tower. Operations officers will maintain appropriate records.

II QUARANTINE OF PERSONNEL - (Reference ATC Memo 25-11, AAF Reg 61-3)

1. All personnel originating within South Atlantic Division for travel to stations in other divisions will be inspected and furnished an individual medical clearance certificate signed by medical officer certifying that individual is free from infectious and communicable disease, free from vermin and has satisfied immunization requirements. Where processing is responsibility of any agencies other than ATC, acceptance by ATC for transportation will be contingent upon possession of medical clearance. Civilian medical inspections will be accomplished by ATC Station Surgeon at originating station.

2. In those cases where South Atlantic Division stations are intermediate stops for personnel traveling from one area to another, reinspection will not ordinarily be accomplished. In such cases certification appearing on incoming aircraft manifests (See 9b. Sec II, ATC Memo 25-11) will be placed on outgoing manifests. In those cases where the outgoing load includes passengers whose names had not been certified on an incoming manifest, individual certificates will be required from the uncertified individuals.

3. When any individual previously certified is detained for medical reasons Station Flight Surgeon will furnish a new individual certificate of clearance or bring old certificate up to date by placing date of most recent inspection and his signature on certificate in individuals possession.

4. ATC Station Surgeon will accomplish reinspection of any individual or group whenever he deems necessary because of lapse of time since last inspection or because of conditions to which individual or group have been exposed.

III QUARANTINE OF PLANTS, ANIMALS AND THEIR PRODUCTS

1. Provision of AAF Reg 61-3 and ATC Memo 25-11 are applicable.

2. Whenever animals, plants or products are found aboard aircraft passing through South Atlantic Division and properly authorized permit cannot be shown, such animals, plants or products will be removed from aircraft and proper disposition will be made.

BY ORDER OF COLONEL FERGUSON:

WALTER I MILLER
Lt. Colonel, GSC
Chief of Staff

OFFICIAL:

/s/ JOSEPH W. KELLOGG
Major, Air Corps
Acting Adjutant General

SoPac-473-rgr
P2-4

SOUTH PACIFIC AREA AND FORCE
Headquarters of The Commander

Serial 02260

10 November 1944

CONFIDENTIAL

SOPAC CONFIDENTIAL LETTER #9-44

From: Commander South Pacific Area and South Pacific Force
To : South Pacific Area and South Pacific Force

Subject: Prevention of dissemination of disease-carrying mosquitoes by aircraft, responsibility for.

Reference: (a) ComSoPac Serial 0178, dated 2 September 1942.
(b) ComSoPac Serial 0174, dated 7 February 1943.

1. Reference (a) and (b) are rescinded.

2. Direct responsibility for compliance with the following procedures to prevent dissemination of disease bearing mosquitoes is placed on the Commanding Officer of each airport in the South Pacific Area.

3. The pilot of each plane will be responsible for the spraying of individual planes. Disinsectization of each plane will be carried out as follows:

(a) All planes departing from New Caledonia, Efato, Espiritu Santo, Guadalcanal, Tulagi-Florida and the Russell Islands, except for local flights will be sprayed with a freon aerosol insecticide dispenser (mosquito bomb).

(b) Spraying will be done after full loading of fuel, baggage, cargo, passengers and crew and prior to the take off.

(c) All doors, windows, hatches and other openings will be closed during spraying and for two (2) minutes thereafter. A watch with second hand will be used.

(d) Spraying of any compartments and other places which are inaccessible from within the plane will be done by the ground crew when the loading is completed.

(e) Completion of spraying will be signalled to the control tower. Aircraft will not be cleared for take-off until the disinsectization has been indicated to the control tower. Commanding Officers of airfields will maintain appropriate records to show that each

plane has complied with this directive.

(f) Spraying time will be as follows:

Spraying Time Aerosol Dispensers	Type of Aircraft
3 seconds	Single Seat and Two Seat Planes
15 seconds	B17, B25, PV, PBD, C63, C60, B2, A20
25 seconds	B24, C87, C47, PB4Y, PBY, PB2Y, PBM, DBB
40 seconds	B29, C54, etc.

4. Civilian pilots of aircraft under military jurisdiction, not complying with these provisions, will be suspended from further flight pending action by the Commander South Pacific.

5. Control towers at all bases in the South Pacific Area will query incoming planes from other theaters to determine if disinsectization as outlined in paragraph 3, has been performed at the last take-off prior to entry into this area. If this precaution has not been taken, discharge of passengers and cargo will be deferred until the disinsectization has been accomplished, and indicated to the control tower.

J. H. NEWTON

G. E. PRALL
Assistant Flag Secretary

Distribution List II

TRANSLATION

Decree-Law 5,181 of January 11, 1943
"Diario Official," January 13, 1943

DISINFESTATION OF AIRCRAFT ARRIVING FROM AFRICA

Measure with a view to the prevention of the entrance, into Brazil, of the **Anopheles** Gambie.

Regarding regulations of transportation of live arthropods by plane, the President of the Republic signed the following decree-law:

Art. 1 - All aircraft which have touched at any point of the African continent must, on arrival in Brazil, be free from any living arthropods.

Art. 2 - Advance notice must be given to the sanitary authorities, as required by them, of the arrival of any aircraft from Africa.

Paragraph - The National Health Department, whenever it judges necessary, shall designate to the "Diretoria de Aeronautica Civil," the cases in which notification shall also be given of the arrival of aircraft from other areas.

Art. 3 - Any aircraft arriving in Brazil and having called at any point in the African continent or at any other place where, according to the judgment of the National Health Department, there may be any disease transmissible by Arthropods, shall be thoroughly disinfested by efficient chemical material, prior to disembarking of any person or removal of any object.

Sec. 1 - The disinfestation shall be carried out by order of the sanitary authority.

Sec. 2 - The aircraft must be thoroughly closed, before landing; the functioning of the equipment of air renovation suspended and maintained in this condition, while disinfestation is carried out.

Sec. 3 - Before disinfestation, the existence of living arthropods will be verified.

Sec. 4 - The sanitary authority carrying out the disinfestation shall record in the aircraft documents, the following:

a) hour of closing of the aircraft and shutting off of the apparatus of air renovation;
b) hour of arrival;
c) hour of beginning of disinfestation;
d) hour of termination of disinfestation;
e) hour of opening of the aircraft;
f) insecticidal material employed;
g) quantity used;
h) type of disinfestation apparatus employed;
i) arthropods caught before disinfestation;
j) arthropods caught after disinfestation;
k) name of the authority responsible for the disinfestation and names of those in charge of carrying it out.

Art. 4 - The sanitary authority, in the accomplishment of its functions, shall be freely admitted to the maneuvering fields of any airport as well as to any aircraft.

Art. 5 - The violation of the provisions of Art. 1 of this decree-law, verified upon disinfestation of the aircraft, shall be punished with the following penalties:

a) Company or owner, in case the aircraft is private property, will be fined Cr. $3,000.00, which shall be doubled in case of second offense;
and

b) the commander, or pilot, in case of official aircraft, will be fined Cr. $1,000.00, which shall be doubled in case of second offense.

Paragraph - The same penalties shall be imposed in case the notification, referred to in Art. 2, is not given and also in case of infringement of the provisions of Sec. 2, Art. 3, of this decree-law.

Art. 6 - Whosoever, in any way, hinders the action of the sanitary authority in the execution of this decree-law, shall be liable to a fine Cr. $500.00, which shall be charged in double upon second offense.

Art. 7 - The sanitary authority shall resort to police authority whenever the intervention of the latter may be necessary for the execution of the measures of this decree-law.

Art. 8 - The dispositions of this decree-law shall fully apply to aircraft flying from one area to another within the national territory, whenever, in the judgment of the National Health Department, the transportation of living arthropods may occasion severe danger to the public health.

Art. 9 - This decree-law shall come into effect on the date of its publication, all contrary dispositions being thereby revoked.

Rio de Janeiro, 11 de Janeiro de 1943, 122°. da Independencia e 55°. da Republica.

(AA) GETULIO VARGAS

GUSTAVO CAPANEMA

SELECTED BIBLIOGRAPHY OF PUBLICATIONS
AND MANUSCRIPTS REGARDING AIRCRAFT DISINSECTIZATION

Army Air Forces Center, Orlando, Florida; Tests conducted by AAF Tactical Center...With the cooperation of the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine; Preliminary Report on Disinsectization of Aircraft, Using DDT; AAF Board Project No. 4671B725, Date 22 August 1945; prepared by Alexander B. Klots, Captain, Sanitary Corps, AFCTR Project Officer.

Report on studies of DDT aerosol disinsectization of aircraft. Far heavier doses are necessary for safe mosquito and housefly disinsectization than had been supposed. Especially with some agricultural pests. No reliance can be placed on DDT-pyrethrum aerosols.

Dethier, V. G., Captain, Sanitary Corps; The Transport of Insects in Aircraft; MS Report, typescript, 7 pp, 1 table, n.d. (May 1945); Copy in AAFCADI files, OAAB.

Report on 16 months collections and observations of insects in aircraft in Central Africa.
A total of 2006 insects of 210 species, 86 families and 13 Orders were collected. Insect behavior in aircraft is described at length.
Tests were made on the ability of mosquitoes to survive flight in engine nacelles.
The possibilities of airport sanitation are described.

Dunnahoo, G. L.; Insect Control in Aircraft; Soap and Sanitary Chemicals, February 1943, p. 111-113.

Egypt, Government of; Minister of Hygiene; Ministerial Order Concerning the Application of Quarantine Measures to Aircrafts (sic) treated by means of Insecticide DDT; 16 April 1945 and 21/4/45.

Requires disinsectization upon landing at Egyptian airfields of aircraft arriving from regions infested with Anopheles gambiae.
Exempts aircraft "treated internally" by means of DDT during the ten weeks following the treatment.

Federal Security Agency, United States Public Health Service; Quarantine Laws and Regulations of the United States and International Treaties Applicable to Aerial Navigation; United States Government Printing Office, Washington, 1942, IV plus 37 pp..

Griffin, Charles V., Captain, Sanitary Corps; Disinsectization of Aircraft with DDT and Kerosene Solution; MS Report, typescript, Hq 1202 AAFBU, Central African Division, Air Transport Command, 3 pp and 2 tables.

Report on experimental work in A-20, C-54 and C-47 aircraft painted internally with 3-5% DDT in kerosene, and tested with adult mosquitoes. Excellent control was obtained.

Interdepartmental Quarantine Commission, Washington, D.C.; Final Report; 10 June 1944.

An extremely thorough report on the entire field of international quarantine, by representatives of the United States Public Health Service, United States Navy and United States Army. Contains much discussion of the transportation of insects in aircraft, aircraft disinsectization problems, etc. and a suggested revision of the regulations dealing with this subject.

Klots, Alexander B., Captain, Sanitary Corps; Experiments on DDT Residual Spray - Treatment of C-47 Airplanes; MS Report, typescript, Office of The Medical Inspector, Station Hospital, Laurinburg-Maxton AAB, 32 pp and 16 plates, n.d. (December 1944). Copy in AAFCADI files, Orlando, Florida.

Several types of DDT solution sprays applied in C-47 aircraft and tested with cages of Aedes aegypti during flight gave somewhat inconclusive results when tests were continued from 6 October to 1 December. A valuable residual toxicity was, however, demonstrated in most tests. Spraying equipment for residual DDT treatment of aircraft is improvised, tested and reported upon.

Knies, Philip T., Lt Colonel, M.C.; Quarantine and Disinsectization of Aircraft; The Air Surgeon's Bulletin, October 1944, Vol. 1, No. 10, p 16-18.

Contains a very brief resume of the provisions of AAF Regulation 61-3, 9 August 1944.

Mackie, F. P. and H. S. Crabtree; The Destruction of Mosquitoes in Aircraft; The Lancet, August 20, 1938, p. 447.

Report on the development of an "automatic" spray release apparatus for aircraft, based on work done in an Imperial Flying Boat in Africa.

Madden, A. H., Arthur W. Lindquist and E. F. Knipling; Special Report on the Use of DDT Residue Treatment of Airplanes for the Prevention of Insect Introduction; Mimeographed report, April 28, 1944, M-723, M&A Document, U.S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine, Orlando, Florida, 7 pp.

Report on work conducted in a number of aircraft and in the laboratory. Solutions, emulsions, aerosols and dusts containing DDT were tested for toxicity. The results indicated the potentialities of DDT for aircraft treatment. This is the

first report on DDT aircraft disinsectization research.

Madden, A. H., Arthur W. Lindquist and E. F. Knipling; DDT Treatment of Airplanes to Prevent Introduction of Noxious Insects; Journal of Economic Entomology, April 1945, Vol. 38, No. 2, p. 252-254.
Report on the same work described in mimeographed document by same authors dated April 28, 1944 (see above).

Magath, T. B. and P. T. Knies; Modern Concepts of International Quarantine with Special Reference to Military Traffic; The Military Surgeon, March 1945, Vol. 96, No. 3, p. 209-222.
Contains a discussion of aircraft disinsectization.

Mulrennan, John A., Melvin Goodman and R. C. Shannon; The Importation of Exotic Anophelines Into the United States; Journal of the National Malaria Society, March 1945, Vol. 4, No. 1, p. 56-58.
A short summary of airborne Anopheles importations in the U.S. with discussion of the problems involved.

Snow, Donald L.: A Preliminary Report of the Development of Equipment for the Automatic Disinsectization of Airplanes; Pan American Sanitary Bureau, United States Public Health Service. (Washington, D.C.) August 15, 1945.
Description, plans and illustrations of an extremely promising, light weight apparatus for release of aerosol spray from nozzles in various parts of an aircraft, controlled by pilot.

Williams, C. L.; Disinsectization of Aircraft; Public Health Reports, June 7, 1940, Vol. 55, p. 1005-1010.
A discussion of the needs and methods for aircraft disinsectization.

PROPOSED REVISION

AAF REGULATION)
NO. 61-3)

HEADQUARTERS, ARMY AIR FORCES
WASHINGTON,

FLYING, OUTSIDE THE UNITED STATES

QUARANTINE

(This Regulation supersedes AAF Regulation 61-3, 9 August 1944)

* * * * * * *

IV - DISINSECTION OF AIRCRAFT

12. In view of the danger of introduction of insects which are economic hazards or vectors of disease, aircraft under Army jurisdiction will be disinsectized as follows:

a. Aircraft entering the United States, its territories or possessions, will, when required by civil regulations, be disinsectized in accordance with pars 13 and 14. The United States Public Health Service has agreed that these provisions fulfill its requirements.

b. Aircraft entering a foreign area will comply with the requirements of the country concerned for disinsection. These requirements, if considered inadequate to protect the interest of the United States Army, will be supplemented by the measures provided by paragraph 13.

13. Disinsection, except as noted in pars 12b and 14, will be carried out as directed below and in Appendix I. It will be accomplished in two ways, both of which will be utilized. These are:

a. Aerosol Disinsection. Disinsection with the Aerosol DDT Dispenser will be accomplished on every flight where called for as follows:

(1) By the pilot of the aircraft or under his direction by personnel of the flight crew.

(2) After full loading of fuel, baggage, cargo, passengers and crew, and immediately prior to the warm-up of engines. Engines will not be operating during any part of the disinsection.

(3) With all doors, windows, hatches, gun-ports and other openings to the exterior closed during spraying and for a full five minutes holding period thereafter.

(4) In all cabin, cockpit, baggage, cargo and other compartments and enclosed spaces. If any of these (such as bottom turrets) are inaccessible from within the airplane, they will be sprayed when loading is completed, but before the main fuselage is sprayed; and

(5) Will be certified in the Clearance (AAF Form No. 23 or the equivalent) of the aircraft, as well as signaled to the control tower.

Aircraft will not be cleared for take-off until the disinsection has been indicated to the control tower. Operations officers will maintain appropriate records.

b. Residual Treatment. By the maintenance in each aircraft as necessary, of a sufficient residue of DDT. This residue will be applied at intervals as directed in Appendix II. Aircraft that do not contain such a satisfactory residue will not be used for flights requiring disinsection.

14. Disinsection will not be required of aircraft arriving in the United States, its territories or possessions from:

Continental U. S.	Alaska	Canada and adjacent areas
Iceland	Greenland	British Isles
Galapagos Islands		

Disinsection will be required if flight has originated in other areas or stops have been made at other places under conditions favoring entrance of insects into the planes. All planes will be disinsectized immediately prior to the last take-off before arrival in the Territory of Hawaii.

15. Civilian pilots of aircraft under Army jurisdiction, not complying with these provisions, will be suspended from further flight pending action by the Commanding General, AAF.

By Command of General ARNOLD:

BARNEY M. GILES
Lieutenant General, United States Army
Chief of Air Staff

Attachments:
Appendices I, II, and III.

OFFICIAL SEAL:

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Incl. 26

*APPENDIX I

A. Spraying Instructions:

1. Use Insecticide Aerosol one pound dispenser (QM 51-1-159 or Air Corps supply), following instructions on container or furnished with item.

2. Spray all compartments and spaces, dividing proportionately the overall time indicated in the table below.

   a. Spray each main compartment separately; after spraying and during the five minute holding period, close doors between compartments.

   b. Open all traps, snap-on covers, etc., to permit the insecticide to get into spaces in cupboards, storage boxes, ammunition boxes, camera wells, etc., and beneath flooring.

   c. Direct spray into all semi-enclosed spaces where insects may be hidden, such as beneath flooring, behind armorplate, blukheads, partitions, linings, and ammunition boxes, and inside fairings and vertical stabilizers which can be reached from inside the aircraft.

   d. Immediately before spraying the fuselage, spray thoroughly into all external cargo or passenger blisters, gun turrets, (such as the bottom turrets of bombers), etc., from the outside through small openings, such as ammunition ejection vents.

B. Dosages of Insecticides:

Holding time - five minutes.

Type of Aircraft	Aerosol Dispenser
Single-Seat Planes	15 seconds
B-17, B-25, C-47, etc.	30 seconds
B-24, C-46, C-87, etc.	60 seconds
B-29, B-32, C-54, etc.	90 seconds

Three times the above dosages will be given if, in an emergency, an aircraft is used that has not had an adequate residue treatment.

* Appendix I and II may be amplified and written as a Technical Order if this is considered desirable. They do not seem, however, to be sufficiently lengthy or complex to warrant this.

A. Spraying Instructions:

1. General. A residual spraying of DDT will be applied to all internal surfaces of the aircraft, excepting instruments which will be shielded from the spray. Particular attention will be paid to the spraying of spaces under flooring and behind snap-on fabric linings and armor, etc., to the undersides of flooring, tables and seats, and to all out-of-the-way corners where insects are likely to hide.

2. Frequency of Application. The residue spray should be reapplied every one hundred hour check in the case of aircraft requiring constant disinsection. No aircraft should be cleared for flights on which disinsection is required that have not been sprayed at or since the last one hundred hour check.

3. Spraying Apparatus. The residue should be applied with a fine but definitely wet spray. The atomizing nozzle of the standard knapsack sprayer, Lofstrand model, cylindrical shape, three gallon capacity (Corps of Engineers) is recommended for this. If this sprayer is not available, a paint gun with nozzle adjusted to give a wet spray may be used, but ordinary, fine mist paint gun nozzles are definitely unsatisfactory. The standard QM issue "sprayer insecticide, continuous spray, two quart capacity," can also be used. If sprayers are lacking the residue spray may be applied with ordinary paint brushes, covering all surfaces thoroughly and swishing the liquid into spaces under flooring, etc., that cannot be reached directly.

4. Strength of Application. The spray should be prepared following directions on the container, to form a two and one half per cent spray. This should be applied to all surfaces so as to wet them thoroughly, but lightly enough so that the spray does not run on the surface.

   a. On surfaces where the deposit of the spray is objectionable because of its appearance (such as plexiglas, seats, etc.) the spray should be applied thoroughly, allowed to dry and then wiped off with a dry cloth. This will remove the objectionable appearance, but will leave on the surface enough DDT to be of value. All other surfaces should be sprayed, but not wiped.

5. Preparation of Spray. The materials to be used are contained in a powder which is to be mixed with water as soon as possible before spraying. This will give a satisfactory treatment, if dir-

ections are followed as to strength of spray. It will cause no damage to parts of aircraft or instruments, but should not be sprayed on the latter because of the appearance of the residue.

THE ARMY AIR FORCES BOARD
ARMY AIR FORCES PROVING GROUND COMMAND
Orlando, Florida

16 May 1946

PROJECT DISTRIBUTION LIST

ARMY AIR FORCES BOARD PROJECT NO. 4671B725

DISINSECTIZATION OF AIRCRAFT, USING DDT

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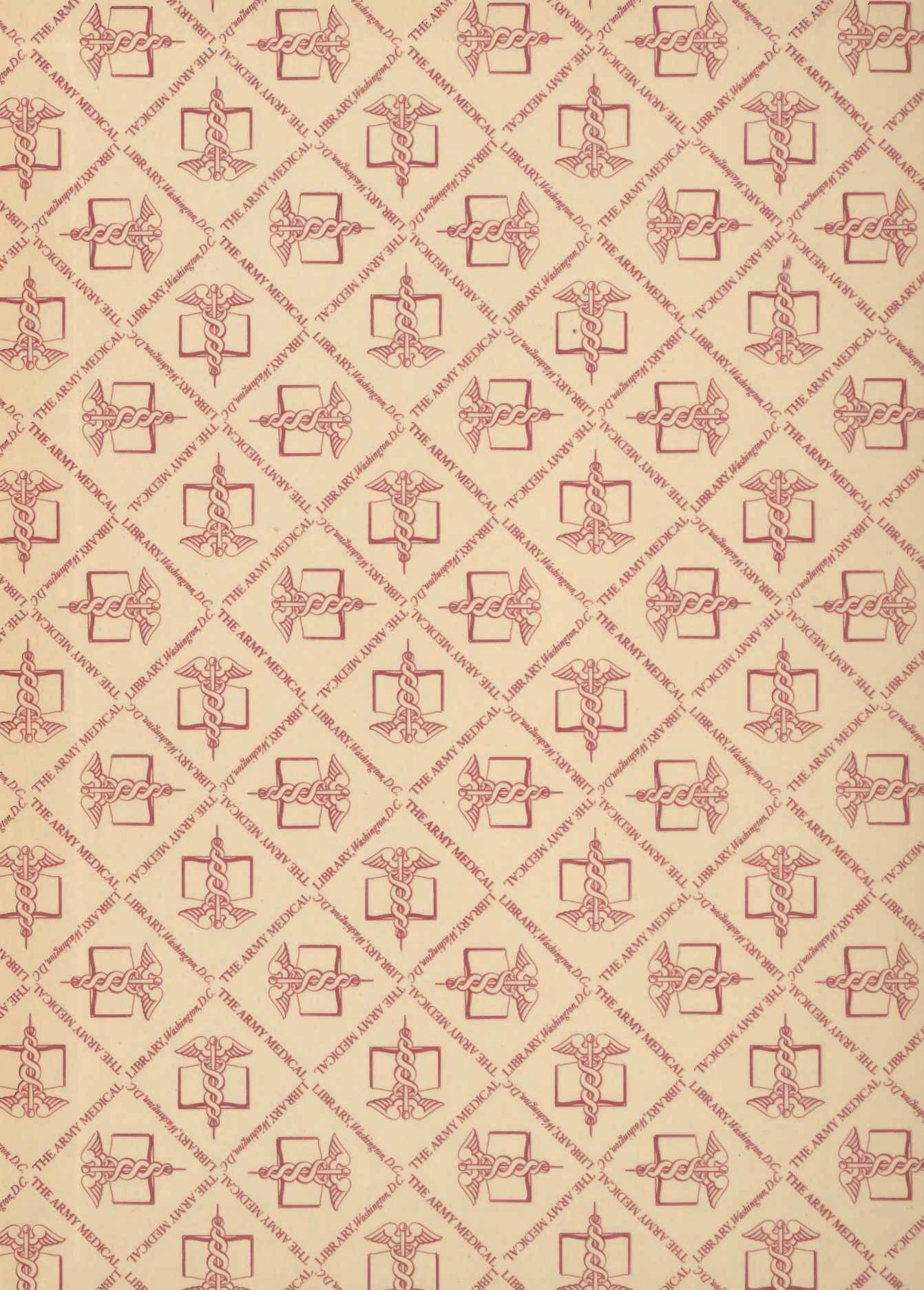
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